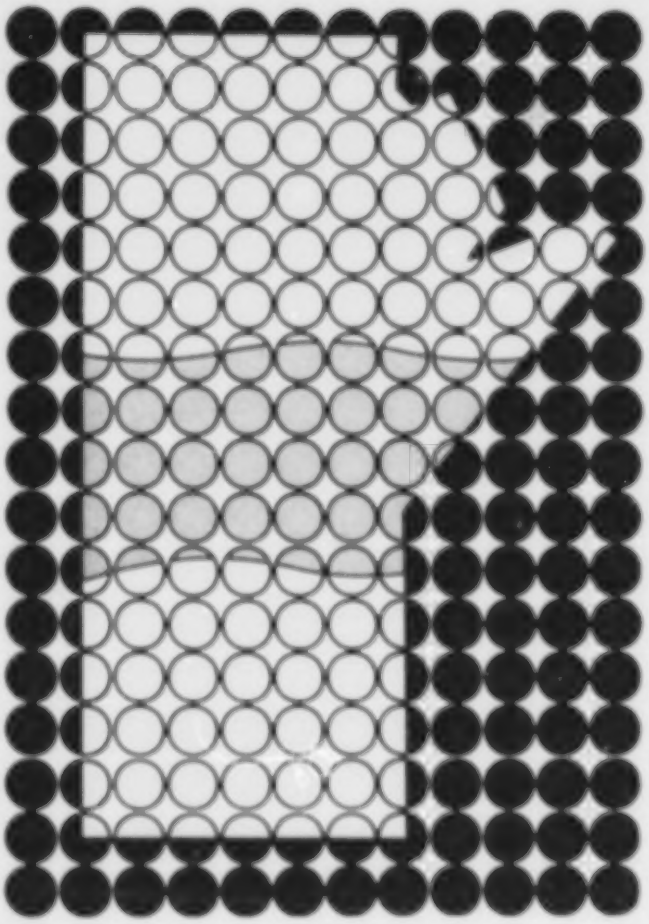

CANADA-MANITOBA Soil Survey

Soils of the South Riding Mountain Planning District

Report D35

Government of Canada / Gouvernement du Canada

Government of Manitoba / Gouvernement du Manitoba

92-01151/

SOILS REPORT No. D35 1990

SOILS OF THE SOUTH RIDING MOUNTAIN PLANNING DISTRICT

WITH

INTERPRETATIONS FOR AGRICULTURE, ENGINEERING and RECREATIONAL LAND USE

1. Seech Lake Area
2. Morod Lake Area
3. Stewart-Thomas Lakes Area
4. Jackfish Lake Area
5. Ozerna Area
6. Otter Lake Area
7. Crawford Park Area
8. Bottle Lake Area
9. South Lake Area
10. Octopus Lake Area
11. Gertrude Lake Area
12. South Pacey Lake Area
13. Kerr Lake Area

by

R.G. KILLERN and G.W. LELYK

CANADA-MANITOBA SOIL SURVEY

CANADA DEPARTMENT OF AGRICULTURE

MANITOBA DEPARTMENT OF AGRICULTURE

DEPARTMENT OF SOIL SCIENCE, UNIVERSITY OF MANITOBA

PREFACE

This interim report and map of the detailed field and laboratory study of the soils in portions of the South Riding Mountain Planning District area is one in a new series of such soil survey reports covering special interest areas in southern Manitoba. These reports are in response to a growing awareness by various government agencies that support the Canada-Manitoba Soil Survey, that a knowledge of the development and distribution of the soils of Manitoba is the key to understanding their properties, behaviour and response to management. This awareness requires that soils be described both in terms of their basic properties and the nature of the environmental setting in which they are found. Thus, in the South Riding Mountain Planning District, development for agriculture, recreation and related uses requires delineation of land of high or low suitability for such uses which in turn depends on an accurate and reliable soil map as a basic reference document.

The land resource information included in this resurvey covers approximately 27,700 hectares of land, comprising 13 detailed study areas in the South Riding Mountain Planning District. The projected intensive use of the soils of this area has created a need for more up-to-date, more accurate and more detailed soil information. Increased examination of soils in the field, the use of current aerial photography, the use of improved methods of studying soils in the laboratory, and the accumulated knowledge of the properties and uses of soils over the years, have all contributed to the additional information contained in this new series of reports and maps.

During the course of the resurvey, a large volume of site specific data for the soils mapped in these areas was generated that, for practical reasons, cannot be included in this interim report. These data are archived in the Canada Soil Information System (CanSIS) data bank. This computerized system of data management permits automated manipulation and statistical evaluation of large volumes of data for soil characterization and interpretations. These data are available on request. In addition, the Cartographic File of CanSIS provides a capability to produce derived maps of various kinds quickly and inexpensively. The types of derived maps that can be generated from the basic soil map include the sixteen interpretations that are provided in tabular form in this report as well as a number of single feature maps such as drainage, texture of surface deposits, slope, and stoniness. A package of interpretive maps and single feature derivative maps can be made available on request from the Canada-Manitoba Soil Survey, Ellis Building, University of Manitoba, R3T 2N2.

ACKNOWLEDGEMENTS

The soil survey of the South Riding Mountain Planning District was conducted as a joint project of the Canada Department of Agriculture, Manitoba Department of Agriculture, and the Soil Science Department, University of Manitoba in support of a request from the Municipal Planning Branch.

The soils were mapped by R.G. Eilers, B.E. Halstead, G.W. Lelyk, E.O. Osborne, and I.G. Podolsky. Assistance in the field was provided by T. Thorlesfson, B. Graham, G. Shaw, K. Koots, P. Jonasson, and G. Smith.

Laboratory analysis was conducted by P. Haluschak, R. Mirza, J. Madden, and K.C. Yeung.

Cartographic Services

Mapping bases were provided by the Land Resource Research Centre, Ottawa. Map compilation and digitizing in preparation for publication and addition to the CanSIS Cartographic File were provided by J. Griffiths and M. Brown.

Sketches and layouts were drafted by J. Griffiths and R. De Pape.

Manuscript review and soil correlation were provided by R.E. Smith.

Typing of report manuscript was provided by Barbara Stupak.

SUMMARY

The detailed soil mapping areas described in this report are located immediately south of Riding Mountain National Park. Detailed soil mapping was conducted on a total area of 27,700 hectares consisting of thirteen sub-areas between Townships 17 and 20 and Ranges 16 to 22 west.

The study area, located south of Riding Mountain National Park, is an upland area of undulating to hummocky end moraine with elevation averaging 625 m.a.s.l.

Surface deposits are predominantly loam textured, moderately to strongly calcareous morainal tills. In localized areas, the tills are mantled by thin, coarse sandy to loamy textured, glaciolacustrine veneers and blankets and are dissected by gravelly to sandy textured, glaciofluvial sediments.

The South Riding Mountain Planning District area has a transitional, cool boreal to moderately cold cryoboreal, subhumid continental climate with distinct seasonal highs of temperature and precipitation. The area has an estimated frost-free period of 100 days and an estimated average of 1400 growing days above 5 degrees C.

The irregular hummocky morainal topography lacks a well developed drainage network, resulting in numerous, small undrained depressions and lakes. Soils are, therefore, dominantly well drained on the slopes with a short transition to very poor drainage in the depressions.

The soil parent materials consist mainly of glacial till (39 percent of the total surface area); sandy and loamy veneers overlying till (3.0 percent); loamy glaciolacustrine blankets (21.5 percent); sandy and gravelly glaciofluvial deposits (11.3 percent); organic deposits (9.6 percent).

The dominant soils in the study area are Dark Gray and Black Chernozems (49.8 percent) occurring in the well and imperfectly drained positions. The Gray Luvisols (19.6 percent) occupy the well and imperfectly drained positions at elevations generally above 580 m.a.s.l. Moderately decomposed Typic and Terric Mesisols are the most common organic soils occupying 9.6 percent of the area. Humic Luvic and Rego Humic Gleysols are the most common wet mineral soils in the map area (9.3 percent).

The agriculture potential of the soils in the South Riding Mountain Planning District ranges from class 1 to class 6. Topography, poor drainage, surface ponding, stoniness and erosion are the major soil conditions affecting capability and land management in the area. The majority of the soils in the study area range between class 3 and class 5. A number of soils limited in extent in the study areas would have a class 2 irrigation suitability rating. The majority of the soils in the area have been rated as classes 3 and 4 for

sprinkler irrigation because of the limiting presence of a less permeable, more compact subsurface layer. Topography is also the major limitation to irrigation in some areas.

The predominant soil conditions which present problems for engineering and recreational development are topography and surface ponding. The presence of many small, water filled depressions and channels influence road planning and, to some extent, road maintenance due to wetness and frost heaving. The general area is well supplied with granular aggregate deposits suitable for road construction purposes.

Recreation development such as cottaging, camping and picnic areas has occurred adjacent to the major lakes in the area. However, other areas in the study area have potential for further recreational development.

HOW TO USE THIS SOIL REPORT

This report on the Soils of the South Riding Mountain Planning District Area contains considerable information about the soils, their origin and formation, their classification and their potential for various uses such as dryland agriculture, irrigation, engineering and recreation. The report is divided into four parts: Part I provides a general description of the area; Part 2 describes the methodology used in the study; Part 3 discusses the development, scientific classification and morphological characteristics of the soils in the study area, and Part 4 provides an interpretation of soil properties and associated landscape features as they affect soil capability or suitability for various uses.

The soil maps of the study area are compiled on uncontrolled air photo bases which are included in a pocket of the report folder. The maps show the distribution of soil types and associated landscape features that are significant for potential use as field management units. They provide a linkage from landscapes within the study area to the information contained in the report.

To assist the user in retrieving soil information quickly, the following steps are suggested:

Step 1 Consult the soil maps in the pocket of report folder. Locate the area(s) of interest on the maps and identify the pertinent map unit symbols. Arabic numerals placed as superscripts following map symbols indicate the approximate proportion of each soil type within the map unit.

Step 2 Consult the extended legend accompanying the soil map for an alphabetical listing of soil symbols giving the soil name, classification, drainage and related information concerning landforms, nature and depth of materials, and dominant vegetation.

Step 3 For interpretive information about the soils, consult the appropriate Table in Part 4. Criteria utilized as guidelines in making these interpretations are provided in the Appendix.

Step 4 Further information concerning the morphological properties and extent of the soils is presented in Part 3 where the soils are described alphabetically according to soil name.

Step 5 Additional site-specific information not contained in this report is available on request from the Canada-Manitoba Soil Survey, Ellis Building, University of Manitoba.

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PART 1

GENERAL DESCRIPTION OF THE STUDY AREA

1.1 LOCATION AND EXTENT

The South Riding Mountain Planning District refers to the general area south of Riding Mountain National Park (Figure 1). The study area includes selected areas adjacent to the southern boundary of the National Park and other areas immediately surrounding some of the smaller lakes. The specific areas covered in this soil survey project are shown in Figure 1, and include the following extents and locations:

1. Beech Lake Area (520 ha), Twps. 19 & 20, Rge. 22W
2. Horod Lake Area (557 ha), Twp. 19, Rge. 21W
3. Stewart-Thomas Lakes Area (3,826 ha), Twps. 18 & 29, Rges. 20 & 21W
4. Ozerna Lake Area (1,939 ha), Twp. 17, Rge. 20W
5. Jackfish Lake Area (979 ha), Twps. 17 & 18, Rges. 19 & 20W
6. Bottle Lake Area (3,503 ha), Twps. 18 & 19, Rges. 19 & 20W
7. Crawford Park Area (2,151 ha), Twps. 19 & 20, Rges. 19 & 20W
8. South Lake Area (3,367 ha), Twp. 29, Rge. 19W
9. Octopus Lake Area (3,986 ha), Twp. 19, Rges. 18 & 19W
10. Gertrude Lake Area (1,163 ha), Twp. 18, Rges. 18 & 19W
11. South Pacey Lake Area (739 ha), Twps. 18 & 19, Rge. 18W
12. Otter Lake Area (4,397 ha), Twps. 17 & 18, Rges. 17 & 18W
13. Kerr Lake Area (571 ha), Twps. 16 & 17, Rge. 17W

The total land surveyed at 1:20,000 scale was approximately 27,700 ha.

A small area south of the Park entrance and surrounding the town of Onanole (soils of the Onanole Area by Michalyna and Hopkins 1968, Report D-11), has been included in this study because of its relevance to the project.

Other areas in the vicinity have also been resurveyed and published. They are: Soils of the Sandy Lake Area, Report D-25 (Michalyna and Holmstrom 1980); and Soils of the Deep Lake Area, Report D-11 (Hopkins and Smith 1975).

All of these projects are resurveys of specific portions of the area previously reported in the Reconnaissance Soil Survey of the Rossburn-Virden map area, Report No. 6, 1956, and the Westlake map area, Report No. 8, 1958.

1.2 LAND USE

Agriculture is the dominant land use in the study area. Mixed farming and ranching with feed grains and forages are the most common enterprises. These activities are well suited to the cool, subhumid climate, and the rough hummocky topography of the area.

Other minor types of land use include residential, recreational and wildlife management areas.

1.3 PHYSIOGRAPHY

The South Riding Mountain Planning District occupies much of the southern slopes of the Riding Mountain Upland. The Riding Mountain Upland (Figure 2) occurs between 500 and 750 m.a.s.l. with the majority of the area, including the thirteen map areas, characterized by undulating to hummocky end moraine, glaciofluvial, and lacustrine landforms.

1.4 BEDROCK

The underlying bedrock consists of light gray, hard shale and soft greenish shales. Geologically, these shales are part of the Odanah beds of the Riding Mountain Formation of the Upper Cretaceous Period. The depth to bedrock varies from approximately 30 m south of Seech Lake to more than 120 m south of Bottle Lake (Report Nos. 11[1] and 16,[2] Groundwater Availability Studies, Water Resources Branch).

1.5 SURFACE DEPOSITS

Pleistocene glaciation covered these uplands, resulting in the deposition of extensive end moraine and stagnant ice morainal deposits. These till deposits reflect the nature of the bedrock over which the glacial ice has moved. The glaciation has incorporated fragments of the shale bedrock, resulting in the medium to fine textured matrix with Paleozoic dolomite and limestone along with Precambrian granitic rock forming the cobble to boulder size fragments in the till.

Minor occurrences of glacial fluvial material are present in ridges adjacent to former glacial meltwater channels. Larger areas of glaciofluvial materials such as outwash and deltaic fans are also associated with the former glacial meltwater channels.

Lacustrine deposits occur throughout the study area, generally in association with the lakes and larger wetland areas. The landforms have variable surface expression ranging from hummocky, moderately sloping to level.

Minor organic deposits occur in many poorly to very poorly drained depressions in flat-lying areas and along some shorelines of the numerous lakes. In the wettest regions, non-woody fen peat predominates; woody fen type peat deposits are located in the lower, poorly drained sites, not necessarily associated with open bodies of water. The type and extent of surface deposits and soils are summarized in Table 1.

---

[1] 1972 - Groundwater Availability Study, Report No. 11, Neepawa Map Sheet (62-J), Water Resources Branch, Manitoba Department of Natural Resources.

[2] 1978 - Groundwater Availability Study, Report No. 16, Riding Mountain Map Sheet (62-K), Water Resources Branch, Manitoba Department of Natural Resources.

1.6 RELIEF

The overall relief of the South Riding Mountain Planning District study area varies from a high of 670 m.a.s.l. in the east, to a low of 575 m.a.s.l. in the west. The topography is complex ranging from hummocky, very gently sloping to strongly sloping (slopes 0.5 to 30 percent) to undulating (slopes less than 5 percent).

1.7 SURFACE AND SUBSURFACE HYDROLOGY

Surface water drainage is influenced largely by the numerous lakes and small ponds which serve as major catchment areas for the surrounding landscape (Figure 3). As a result of the undulating to hummocky relief, the areas lack a developed drainage network. Consequently, water is ponded in the many, small undrained depressions and lakes. Surface water flows from the wetlands through a network of adjoining lows toward the lakes during periods of above normal runoff or precipitation. During periods of high water in the lakes, the outflow is to the west and southwest towards the Minnedosa River. The slow permeability of the till does not favour the movement of large quantities of water into the ground. Groundwater is available in limited quantities found in sandy or gravelly strata in the till. For more information the reader is referred to the Groundwater Availability Studies (Report Nos. 11 and 16) for the Neepawa and Riding Mountain map sheets, respectively.

1.8 CLIMATE

There are no long term weather recording stations in this study area. Since it is located on the southern slopes of the Riding Mountain Upland, precipitation can be extremely variable in both a temporal and spatial sense. Temperature can be more uniform in a spatial sense, but very variable in a temporal sense. However, mean values or parametrical representations do not provide a sense of this variation. Examples of weather records for stations immediately to the north and south of the study area are provided in Tables 2 and 3. The range of conditions is exemplified by comparing the data between Wasagaming (approx. 615 m.a.s.l.) on the northern edge and Minnedosa (approx. 490 m.a.s.l.) on the southern edge of the study area. Mean daily temperatures are consistently cooler at Wasagaming (Table 2) and mean monthly and mean total rainfall is higher (Table 3) than that at Minnedosa. The average annual precipitation at Wasagaming, for example, is 546 mm compared to 490 mm for Minnedosa.

The soil climate is transitional, cool Boreal to moderately cold Cryoboreal, subhumid Continental (Soil Climates of Canada, Clayton et al. 1977)[3].

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[3] Clayton, J.S., Ehrlich, W.A., Cann, D.B., Day, J.H., Marshall, I.B. 1977. Soils of Canada, Agric. Can. Publ. 1544, 2 vols.

1.9 VEGETATION

This area lies within the Boreal Forest Region as delineated by Rowe, 1972[4]. The native vegetation consists predominantly of mixed woods including aspen, white spruce, and paper birch, with minor occurrence of green ash, Manitoba maple and bur oak. In the level to depressional, poorly drained and peaty areas, the vegetation often consists of black spruce, tamarack and sedge. Willows are common around the margins of permanently wet depressions, sloughs and small lakes. Many of the shallow depressions and sloughs contain cattails, bull rushes, and slough grasses.

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[4] Rowe, J.S. 1972. Forest Regions of Canada. Canadian Forestry Service, Department of the Environment. Publ. No. 1300.

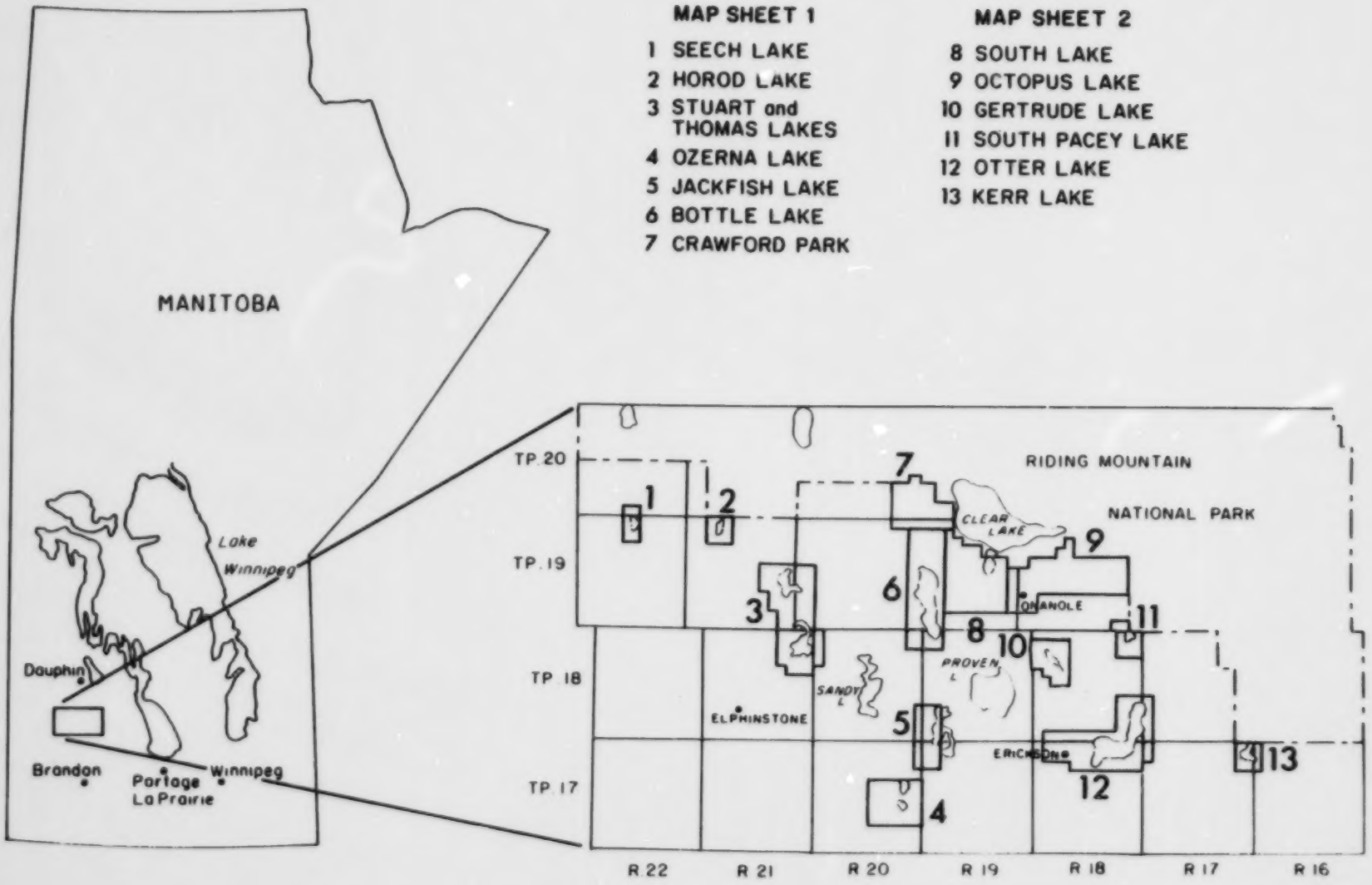

Figure 1: Location of the South Riding Mountain Planning District Study Areas.

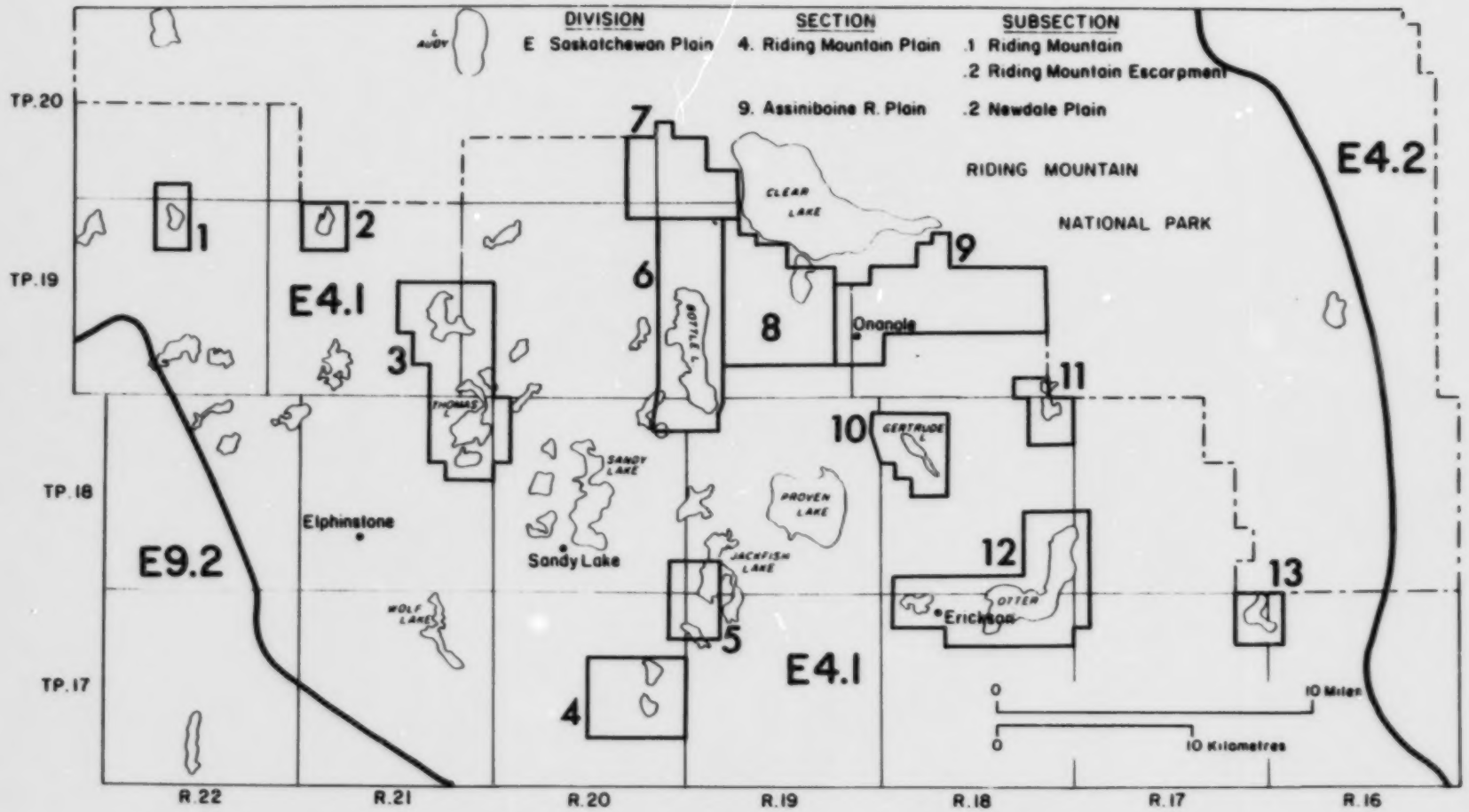

Figure 2: Physiographic Regions in the Riding Mountain Upland Area.

Table 1. Type and Extent of Surface Deposits and Soils

Surface Deposits \ Soils	Luvisols	Chernozems		Gleysols	Organic		Total
	Gray	Dark Gray	Black		Fen	Forest	
Glacial Till							
-Loamy	3,242	5,102	-	726	-	-	9,070
-Clayey	-	1,541	-	132	-	-	1,673
Lacustrine (>1 m Thick)							
-Sandy	281	1,865	318	654	-	-	3,118
-Loamy	-	590	212	-	-	-	802
-Fine Loamy	866	269	143	751	-	-	2,029
(<1 m Thick)							
-Sandy	-	716	-	-	-	-	716
-Loamy	-	107	-	-	-	-	107
-Clayey	-	-	-	-	-	-	-
Fluvial/Outwash (>1 m Thick)							
-Gravelly	873	152	1,804	276	-	-	3,105
1 m Thick	-	-	-	-	-	-	-
Organic							
>1.6 m Deep	-	-	-	-	361	86	447
.4-1.6 m Deep	-	-	-	-	1,886	324	2,210
TOTALS	5,262	10,342	2,477	2,539	2,247	410	23,277
Water Bodies							4,062
Miscellaneous Land Types							306
PROJECT TOTAL							27,645

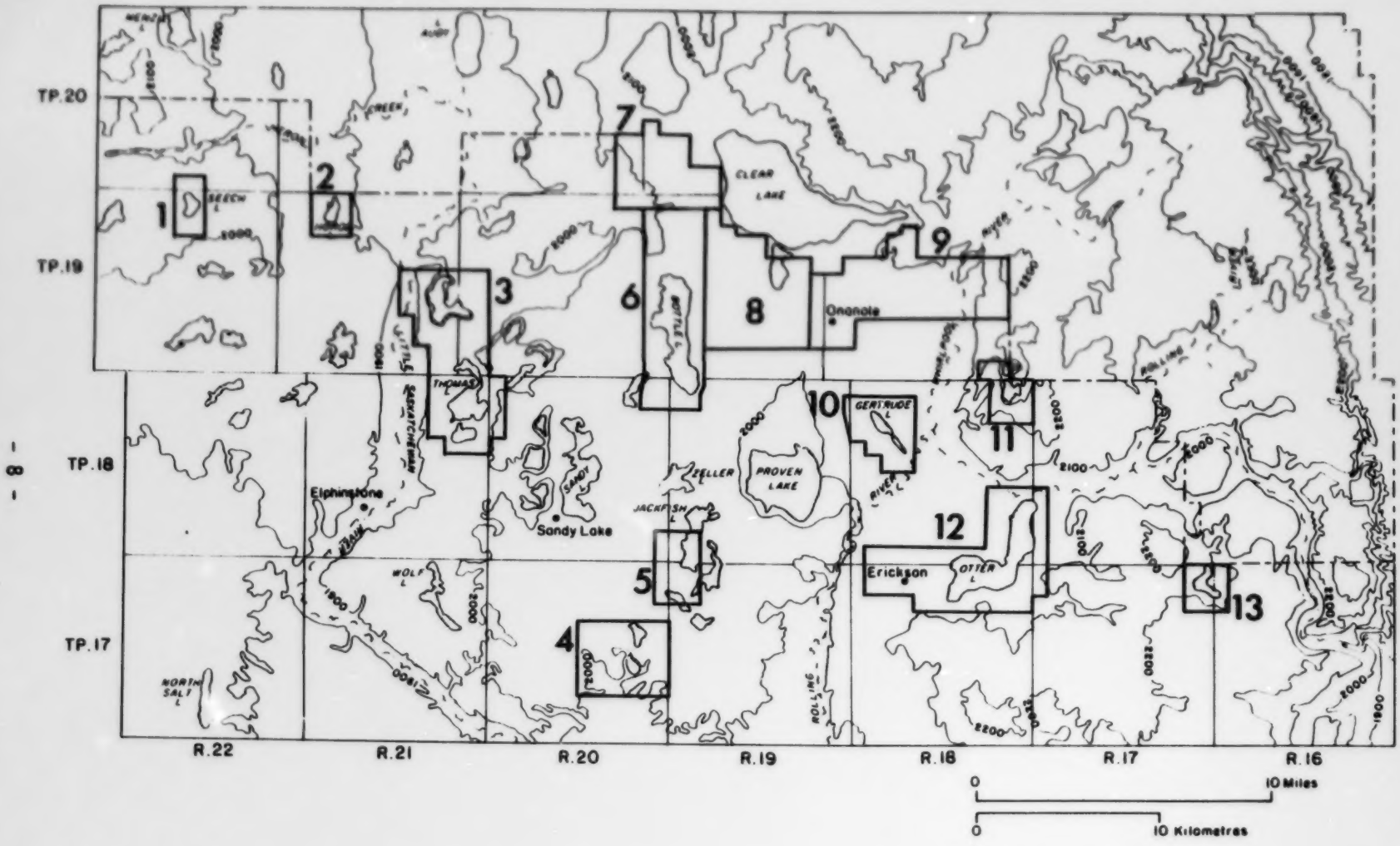

Figure 3: Relief and Drainage of the South Riding Mountain Planning District.

Table 2. Mean Daily Temperatures (Deg. C) for Areas Surrounding the South Riding Mountain Planning District Area*.

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Brandon CDA	-19.3	-15.2	-8.4	3.3	11.0	16.3	19.2	17.9	11.8	5.6	-5.0	-14.1	1.9
Dauphin A	-19.5	-15.6	-9.1	2.3	10.3	15.8	18.5	17.1	11.3	5.5	-5.2	-14.3	1.4
Minnedosa	-19.9	-15.8	-9.2	1.8	9.6	15.0	17.6	16.4	10.3	4.6	-5.9	-15.4	0.8
Neepawa	-19.0	-15.2	-8.7	2.5	10.5	16.1	19.1	17.6	11.7	5.5	-5.1	-14.1	1.7
Riding Mountain Park	M	M	M	8.9	14.3	16.7	15.4	9.8	M	M	M	M	M
Rossburn	-18.9	-15.1	-8.0	2.5	10.8	15.9	18.4	17.2	11.0	5.1	-5.8	-13.8	1.6
Wasagaming	-20.7	-16.9	-10.5	0.7	8.4	13.5	16.2	15.0	9.1	3.8	-6.9	-15.7	-0.3

M - Data Missing

* Canadian Normals, Temperature 1951-1980, Atmospheric Environment Service, Dept. of Environment Canada. Vol. 2 - SI (1982).

Table 3. Mean Rainfall and Mean Total Precipitation (mm) for Stations Surrounding the South Riding Mountain Planning District Area*

		Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Brandon CDA	(MR)	T	0.4	2.3	22.9	49.1	81.2	69.4	69.5	49.6	18.3	3.6	0.2	366.5
	(MTP)	21.3	20.0	23.5	36.8	49.7	81.2	69.4	69.5	49.7	23.4	19.9	20.2	484.6
Dauphin A	(MR)	0.4	0.3	1.7	15.5	43.0	86.3	64.1	62.2	57.7	20.5	2.5	0.5	354.7
	(MTP)	24.5	17.5	24.5	31.9	47.4	86.3	64.1	62.2	59.0	28.9	25.2	24.3	495.8
Minnedosa	(MR)	0.0	0.4	2.0	20.2	49.0	81.3	73.4	62.5	48.2	20.4	2.0	0.3	359.7
	(MTP)	22.6	23.3	28.2	34.2	51.9	81.3	73.4	62.5	48.4	22.7	20.7	21.2	490.4
Neepawa	(MR)	0.1	0.4	0.6	13.2	44.9	69.7	69.6	60.4	55.5	21.9	2.3	0.1	338.7
	(MTP)	21.8	17.6	23.6	25.9	49.7	69.7	69.6	60.4	56.3	29.8	21.6	20.5	466.5
Riding Mountain	(MR)	M	M	M	M	59.2	97.1	80.5	90.3	83.2	15.5	M	M	M
Park	(MTP)	M	M	M	M	66.1	97.1	80.5	90.3	86.8	15.5	M	M	M
Rossburn	(MR)	0.4	1.0	3.2	17.7	44.1	87.7	86.0	65.0	57.2	24.1	2.9	1.0	390.3
	(MTP)	24.6	24.8	30.9	33.5	47.1	87.7	86.0	65.0	59.2	31.7	23.5	25.4	539.4
Shoal Lake	(MR)	0.0	0.5	0.7	14.8	38.7	73.6	74.4	60.6	46.3	17.3	1.6	0.7	329.2
	(MTP)	16.5	17.9	19.0	24.8	41.3	73.6	74.4	60.6	46.6	23.8	16.8	15.5	430.8
Wasagaming	(MR)	0.0	0.5	0.2	15.0	47.4	99.5	74.4	69.9	61.9	23.3	0.9	0.7	393.7
	(MTP)	22.1	21.0	28.1	33.0	50.0	99.5	74.4	69.9	62.2	31.6	29.7	24.5	546.0

MR - Mean rainfall (mm)
MTP - Mean total precipitation (mm)
* Canadian Normals, Precipitation 1951-1980. Atmospheric Environment, Environment Canada. Vol. 3-SI (1982).
T - Trace
M - Data Missing

1.10 GENERAL DESCRIPTION OF EACH SUB-AREA

The large number of sub-areas in the South Riding Mountain Planning District Study Area requires a numbering system which coordinates the report and two map sheets. The thirteen areas illustrated in Figure 4 are numbered on the two maps as follows:

	See Sheet No.
1. Seech Lake Area	1
2. Horod Lake Area	1
3. Steward & Thomas Lakes Area	1
4. Ozerna Lake Area	1
5. Jackfish Lake Area	1
6. Bottle Lake Area	1
7. Crawford Park Area	1
8. South Lake Area	2
9. Octopus Lake Area	2
10. Gertrude Lake Area	2
11. South Pacey Lake Area	2
12. Otter Lake Area	2
13. Kerr Lake Area	2

An outline describing each sub-area according to location and extent, vegetation, parent materials, dominant soil classification and landform description follows.

1. Seech Lake Area

Approximately 2/3 of the area (520 ha) surveyed in Twps. 19 & 20, Rge. 22W is cultivated for cereal crops; the remainder of the area mainly to the north and east of the lake is used for forage and native pasture. Coarse textured soils and numerous wet depressions are the major limitations to farming in this area.

The two major parent materials surrounding this lake consist of very strongly calcareous, medium to moderately fine textured, hummocky morainal till to the south and west, while very strongly calcareous, coarse textured glaciofluvial outwash deposits are common to the north and east. Organic soils derived from fen and forest peat deposits commonly occur in deep depressions throughout the area.

The dominant soils are Luvisols as represented by the Waitville and Zaparoza soil series. The majority of these mineral soils are moderately well to rapidly drained. The poorly drained soils are mostly peaty phases of Gleysolic soils represented by Sinnott, Roblin and Herron Creek Series.

The area is characterized by very gently to gently (2-9%) sloping hummocky morainal deposits and nearly level to gently sloping glaciofluvial outwash deposits.

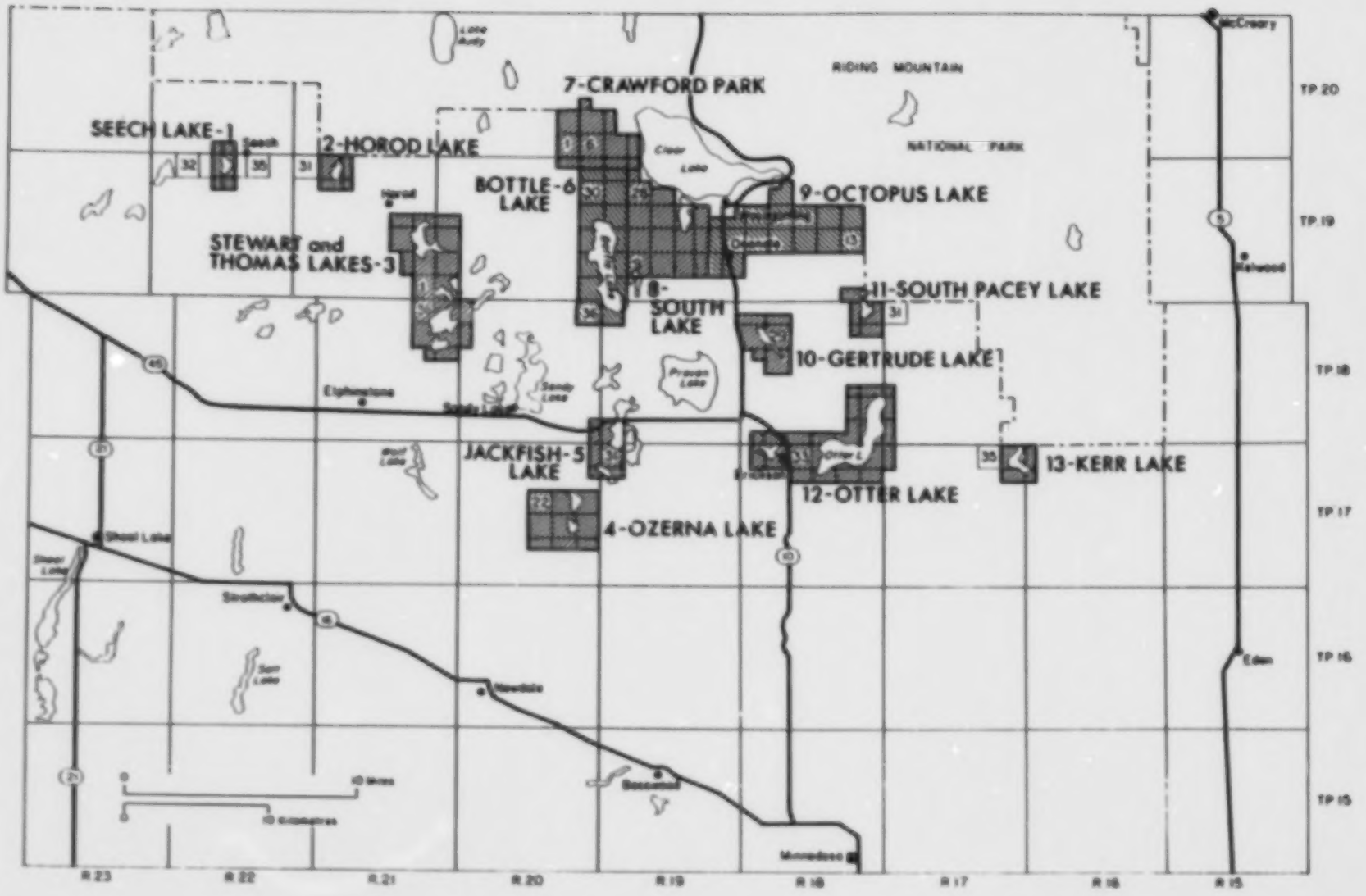

Figure 4: Location of Individual Study Areas.

2. Horod Lake Area

The majority of the 557 hectares surveyed in Twp. 19, Rge. 22W is currently cultivated for cereal crops and forage production. A small area remains under native bush and is also used for pasture. Coarse soil textures, stoniness, and topography are the major limitations for agriculture in this area.

The parent materials comprising this area consist of very strongly calcareous, medium to moderately fine textured gently to moderately sloping hummocky morainal tills and coarse textured, very gently to moderately sloping hummocky glaciofluvial outwash deposits. Shallow to deep fen and forest peat occur in depressions.

The dominant soils are Luvisolic as represented by the loamy Waitville series and the gravelly Zaparoza soil series. Small amounts of sandy textured Blueving soils and Chernozemic Onanole soils are scattered throughout the area. The low lying depressions are wet and contain peaty Gleysols in association with shallow Terric Mesisols and deeper Typic Mesisol organic soils. The Gleysolic mineral soils are represented by Sinnott and Roblin soil series on glacial till and by the Herron Creek series on gravelly sediments. The shallow Terric Mesisols are represented by the Cayer and Kircro series on fen peat and by the Okno and Rat River series on forest peat. The deeper Typic Mesisols are represented by the Stead series on fen peat and the Baynham series on the forest peat deposits.

The area is characterized by very complex, very gently to moderately sloping (2-15%), hummocky deposits.

3. Stewart and Thomas Lakes Area

The 3,826 hectares in Twps. 18 & 19, Rges. 20 & 21W are used predominantly for mixed cereal grain production with some forage and cattle. Wet areas and shorelines are used primarily for native pasture.

Soil parent materials are predominantly medium to moderately fine textured, strongly calcareous morainal deposits with minor coarse textured shaly outwash, and medium to fine textured lacustrine sediments with pockets of shallow organic deposits.

The dominant soils are Luvisolic as represented by the loamy Waitville series; Chernozemic Dark Grays and Blacks by the loamy Erickson and less extensive gravelly Seech series; Gleysolic soils by the loamy Sinnott and Roblin series and minor areas of Terric Mesisols as represented by Cayer and Rat River series.

The map sub-area consists of gently to moderately sloping hummocky morainal deposits, gently sloping lacustrine blankets and veneers, gently to moderately sloping glaciofluvial sediments with level organic forest and fen peat deposits.

4. Ozerna Area

The 1,939 hectares surveyed in Twp. 17, Rge. 20W is used dominantly for cereal grain production, some forage and native pasture.

The parent materials of the Ozerna area consist of moderate to strongly calcareous, medium to moderately fine textured morainal deposits. There are minor areas of moderately to strongly calcareous, medium to fine textured lacustrine sediments adjacent to the water bodies with moderately decomposed organic deposits in localized depressions.

Dominant soils are the Gray Chernozemic, loamy Erickson series and the loamy Gleysolic Sinnot, Roblin and Proven Lake series. Minor areas of shallow, Terric Mesisol soils represented by Cayer series also occur.

The area is characterized by gently to strongly sloping hummocky morainal deposits with lacustrine blankets.

5. Jackfish Lake Area

The 979 hectares surveyed in Twps. 17 & 18, Rges. 19 & 20W surrounding Jackfish Lake is comprised of mixed farms predominantly for cereal crop production.

The surface deposits consist of moderately to strongly calcareous, medium to moderately fine textured morainal till, medium textured moderately calcareous lacustrine sediments and minor inclusions of coarse textured outwash deposits and thin, moderately decomposed organic soils.

The dominant soils are the loamy Gray Luvisolic Waitville and Rackham series, the loamy Gray Chernozemic Erickson and Onanole series. Significant loamy Gleysolic Proven Lake series and minor areas of shallow organic soils (Cayer and Rat River series) also occur.

Gentle to moderately sloping hummocky morainal till and gently sloping hummocky lacustrine blankets and veneers characterize topography of the Jackfish Lake area.

6. Bottle Lake Area

The Bottle Lake sub-area comprises 3,503 hectares, Twps. 18 & 19, Rges. 19 & 20W; 50 percent of the land is being farmed and is under cultivation with cereals, feed grains and forage crops. The remaining 50 percent consists of wetlands and organic soils.

The parent materials consist of gravelly materials deposited as eskers, kames, and fluvial outwash along with medium textured supra glacial lake sediments. Isolated occurrences of glacial till are also present in small areas.

The dominant soils are Gray Luvisols, Peaty Rego Gleysols, Gray and Black Chernozems and Terric and Typic Mesisols. They are described by Saparosa, Onanole, Rackham, Davidson and some Erickson associations.

The hummocky terrain varies from nearly level to very strongly sloping with no differentiation for divergent soils because of the glacial origin of the area.

7. Crawford Park Area

Approximately 50 percent of the 2,151 hectares, Twp. 19 & 20, Rges. 19 & 20W surveyed has been cleared and is presently cultivated for cereals and forage production. The majority of the remaining area is used as treed native pasture.

The parent materials consist of a mixture of materials derived from morainal, lacustrine, glacio-fluvial, and organic origins.

The dominant soils are the loamy Chernozemic Dark Gray, Gray Chernozems, Luvisols, Gleysols, and Terric and Typic Mesisols and are described by Waitville, Seech, Onanole associations, Proven Lake complex and peat.

The sub-area consists of gently to moderately sloping hummocky morainal deposits, very gently to gently sloping lacustrine veneers and blankets, very gently to moderately sloping fluvial deposits and level organic bogs and fens.

8. South Lake Area

The South Lake sub-area, Twp. 19, Rge. 19W has an area of 3,367 hectares. Approximately 85 percent of this sub-area is under cultivation with cereals or forage crops, with some native pasture. The remainder of the sub-area consists of wetlands and organic soils, and a small fraction of the area is too steeply sloping for cultivation.

The deposits in this area vary from a majority of coarse gravelly deltaic or fluvial outwash in the north to coarse to moderately fine lacustrine sediments as blankets or veneers in the south with a mixture of medium to moderately fine morainal tills, lacustrine, and outwash deposits in the center of the area. The dominant soils are the loamy Dark Gray Chernozemic Erickson, Onanole, Davidson series and the gravelly Black Chernozem Seech series, associated with peaty Gleysols and small amounts of Typic and Terric Mesisols.

The area is characterized by nearly level areas surrounding the lake and gently to steeply sloping hummocky or undulating topography in the majority of the area.

9. Octopus Lake Area

The Octopus Lake sub-area totals 3,986 hectares in Twp. 19, Rges. 18 & 19W. Most of the land in the east end of the area is used as native range with mixed farming making up the remainder.

Parent materials consists primarily of strongly calcareous, medium to moderately fine, morainal till. Other materials include moderately to strongly calcareous, coarse to moderately fine textured, lacustrine deposits and some coarse textured, glaciofluvial deposits and minor peat filled depressions.

The soils are comprised of the Luvisolic, loamy Waitville and Rackham series and gravelly Zaparosa series; the Chernozemic Dark Gray Erickson series and the Humic Gleysols, and Terric and Typic Mesisols. They are described gravelly Black Seech series. Associated soils are the loamy Gleysolic Proven Lake series and organic soil complexes.

The area's topography consists of gently to very strongly sloping hummocky morainal tills, gently to moderately sloping lacustrine veneers and blankets and level organic bogs and fens.

10. Gertrude Lake Area

The total area surveyed in Twp. 18, Rges. 18 & 19W is 1,163 hectares. Mixed farming consisting of cereal grains and forage production are the dominant land use.

The major surface deposits consist of medium to coarse textured, moderately calcareous, lacustrine sediments. Other deposits include moderately calcareous, medium to moderately fine textured, morainal

materials; strongly calcareous coarse textured gravelly outwash and variable thicknesses of moderately decomposed organic deposits.

The majority of the soils are the loamy Black and Gray Chernozemic Erickson and Onanole series, and the Luvisolic Rackham series. Associated soils include the loamy Humic Gleysol Proven Lake series and areas of organic soil complexes.

The topography is characterized by slopes ranging from level organics to strongly sloping hummocky lacustrine blankets and veneers and morainal deposits.

11. South Pacey Lake Area

The area surveyed for the South Pacey sub-area in Twps. 18 & 19, Rge. 18W, totals 739 hectares. Presently, native pasture dominates the agricultural use of the area; however, small areas west of the lake have been utilized for crop production.

The dominant parent material consists of very strongly calcareous, medium to moderately fine textured, morainal till. Other materials are morainal clays north of North Pacey Lake and organic materials of fen and forest peat origin.

The dominant soils are the loamy Luvisolic Waitville series. Associated soils include the poorly drained Gleysolic Roblin and Sinnott series and organic soil complexes.

The area is characterized by very gently to moderately sloping hummocky morainal deposits. Deep, level, poorly drained fens and bogs are common in depressions.

12. Otter Lake Area

The Otter Lake area occupies 4,397 hectares in Twps. 17 & 18, Rges. 17 & 18W, and the predominant land use is mixed farming for cereal grain, forage and livestock production.

The parent materials consist of strongly calcareous, medium textured till, weakly calcareous, fine textured till, minor amounts of medium textured lacustrine sediments associated with moderately decomposed organic deposits.

Dominant soils are the loamy Luvisolic Waitville and Rackham series; the loamy to clayey Chernozemic Dark Gray Erickson, Onanole and Meadowbrook series and the gravelly Chernozemic Black Seech series. Significant areas of associated Gleysolic soils like the loamy Sinnott, Roblin and Proven Lake series are found, as are minor areas of Terric and Typic Mesisols (Cayer and Stead series).

The area is characterized by gently to moderately sloping hummocky morainal deposits, very gently to gently sloping lacustrine blankets and veneers with some level bogs and organic fens in localized depressions.

13. Kerr Lake Area

The total area surveyed is 751 hectares in Twps. 16 & 17, Rge. 17W. The majority of the land in this subarea is used for cereal crop production and unimproved grazing. The fringe area around the lake is under natural forest vegetation.

The major parent materials consist of moderately calcareous, medium to moderately fine textured, morainal till. Minor amounts of organic deposits are present in deeper depressions.

The majority of the soils are the loamy Luvisolic Waitville series. Associated soils include the poorly drained Gleysolic Roblin and Sinnott series and organic soil complexes.

The topography throughout most of the area consists of gently to moderately sloping hummocky morainal tills. The shoreline is characterized by moderate to extreme slopes.

PART 2

METHODOLOGY

2.1 SURVEY AND MAPPING PROCEDURES

Soil mapping was conducted by soil scientists who examined soil profiles to depths of one meter along selected traverses in each section. In cultivated or accessible areas the soils were examined at about 150 meter intervals along each traverse; two traverses were made per section of land. Sites adjacent to the traverse and along road allowances were also examined to provide additional ground truthing and to help locate soil boundaries between sections. In less accessible areas, the soils were examined along roads, trails and selected short traverses through critical portions of the section. This field method provided approximately 25 to 30 inspection sites per section or one site per 10 ha. An example of survey intensity can be seen in Figure 5.

At each of the 1,471 soil inspections, detailed information was recorded as to landform, drainage, parent material, and soil profile characteristics for the site and the surrounding terrain. This data, recorded on daily field forms, was later input into the Canada Soil Information System (CanSIS) data bank (see Summary Table, Appendix D). The use of aerial photo interpretation techniques aided in the initial selection of ground truth sites and traverses, and was also used to extrapolate soil conditions and boundaries between inspection sites.

Boundaries delineating the various soil types in the map area were compiled on an air photo mosaic at a scale of 1:20,000 or 3 inches equal one mile. At this scale, the minimum practical size of delineations of significant soil areas is approximately one hectare.

All site specific soils information obtained during the course of this survey project is available on request from the Canada-Manitoba Soil Survey, Ellis Building, University of Manitoba.

2.2 MAP UNITS

The basic unit of mapping in the South Riding Mountain Planning District study area is the soil series. It is defined as a naturally occurring soil body such that any profile within that body has a sequence of horizons whose color, texture, structure, consistence, thickness, reaction and composition are within a narrowly defined range. Soil series, assigned local geographic names and represented on the soils map by three-letter alphabetical codes, also have parent material, drainage, and climatic parameters defined within narrow ranges.

Additional features of the landscape or surface expression which may affect land use interpretations are expressed as phases. Phases include: degree of erosion of the soil profile, slope class, stoniness and salinity and are used when applicable.

These are indicated in the denominator portion of the map symbol.

The delineation of map units, whether they be single soil series or soil series complexes, is not exact; they vary with local topography, drainage, erosion and soil profile properties. The decision to outline and label any given area is based on interpretation and extrapolation of observed soil and landscape features and air photo interpretation. The delineation of soil boundaries serves to separate soils having properties and conditions which are significant for potential use as field management units.

Delineated areas that are homogeneous in soil properties and external features are labelled as simple or pure mapping units. These areas, however, may contain a small proportion of related but unlike soil series or phases. Where different soils or external properties occur in intricate patterns and in such small areas that it is not practical to show them separately because of map scale, they are combined to form compound or complex mapping units. The dominant and significant kinds of related but unlike soil series and phases that occur in such units are indicated in percentile proportions.

Very often, it is desirable to indicate by map unit symbol, minor variations in certain intrinsic properties of soils or landscape features that deviate from the normal. These variants or phases of series usually affect soil management. Four such properties and features are erosion, slope class, degree of stoniness and salinity. The degree or magnitude of each is designated in the following manner:

Erosion
- x - no or only very slight erosion
- 1 - weakly eroded
- 2 - moderately eroded
- 3 - severely eroded
- 0 - overblown

Slope Class
- x - slope classes a-b, i.e. less than 2 percent slope
- c - 2 to 5 percent slope
- d - 5 to 9 percent slope
- e - 9 to 15 percent slope
- f - 15 to 30 percent slope
- g - 30 to 45 percent slope

Stoniness
- x - non stony
- 1 - slightly stony
- 2 - moderately stony
- 3 - very stony
- 4 - exceedingly stony
- 5 - excessively stony

Salinity
- x - non saline
- s - slightly saline
- t - moderately saline
- u - strongly saline

The convention employed to indicate these features in the map symbol is as follows:

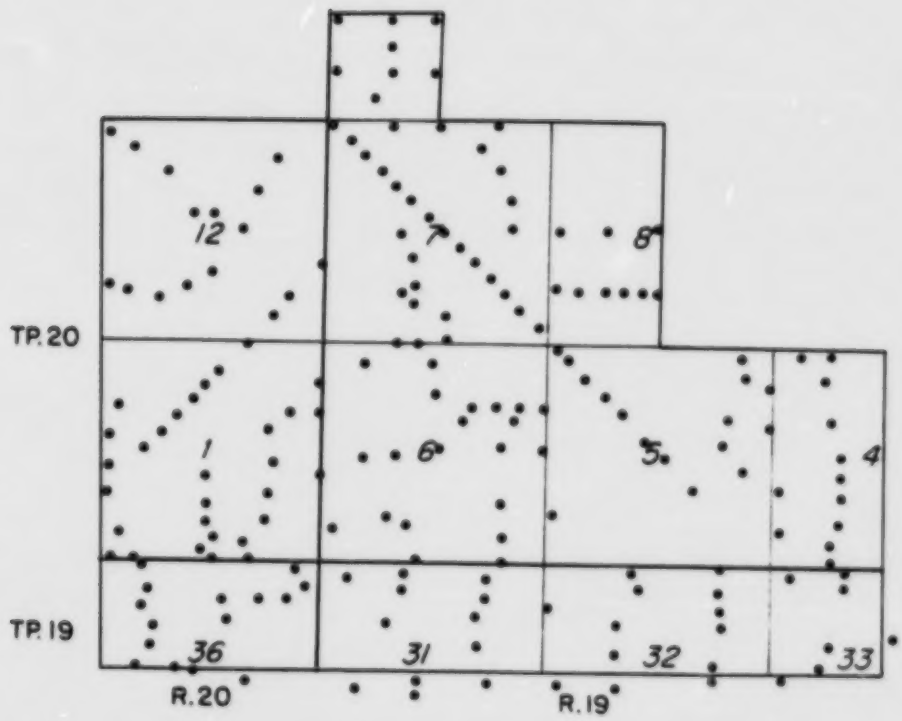

Figure 5: Example of Survey Intensity (Crawford Park Sub-Area).

If none of the above properties are observed to be significant, the map symbol representing the pure or unaffected soil series is used alone without modifiers.

If one or more phase features are used, the appropriate letter or number is placed below the soil series symbol in one of four designated locations in the map unit symbol. The designated order is erosion, slope class, stoniness and salinity. If a particular feature is not observed to be significant, an x is used in its appropriate designated location in the map symbol.

For example, the map unit coded WTV/1e1x indicates that the delineated area is comprised of the Waitville soil series having slight erosion, 10 to 15 percent slopes, slightly stony, and is non saline. Compound symbols, on the other hand, are interpreted as follows:

$$\frac{ECK^{7} - PTU^{3}}{xcxx}$$

A compound map unit consisting of 70 percent Erickson series with no erosion, dominantly c topography (2-5 percent slopes), no stones, and no salinity. The remainder of the map unit consists of 30 percent Petlura series with no modifying phases.

These map units may contain a small proportion of other soils generally not mappable at this scale.

2.3 METHODS OF DESCRIBING SOILS IN THE FIELD

Soils in the study area were sampled and described according to nationally accepted standards and procedures for describing soils in the field[5]. At each site inspection, detailed information was recorded as to landform, drainage, parent material and soil profile characteristics. The record of this information is maintained in the Daily File of the Canada Soil Information System (CanSIS).

During the course of field investigations and mapping, 25 soil sites were sampled at selected locations for soil characterization and classification studies. The description of these soils and analysis of the samples are stored in the Detail File of CanSIS. Selected surface and subsurface samples were analyzed for salinity levels and textural variation and subsurface samples were analyzed for carbonate levels.

2.4 LABORATORY ANALYSIS

Chemical and physical characterization of soils sampled in the study area was determined according to standard laboratory methods and procedures recommended for soil surveys. This analytical data along with the soil descriptions is available on request from the Canada-Manitoba Soil Survey, University of Manitoba.

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[5] Expert Committee on Soil Survey. The Canada Soil Information System (CanSIS). Manual for Describing Soils in the field. 1982. Revised.

2.5 CARTOGRAPHIC PROCEDURES AND CANSIS MAP PRODUCTION

Soil boundaries were drawn on air photographs (scale of 1:15,840, 4 inches equal 1 mile) during field mapping. These photographs show woodlands, buildings, field outlines, roads and other details that help in identifying boundaries accurately. The soil boundaries were reduced and plotted on a soil map manuscript at a scale of 1:20,000 or 3 inches equal 1 mile. This map data in digital form is stored in the Cartographic File of the Canada Soil Information System (CanSIS). The data in this file provides the basis for producing various kinds of derived thematic maps quickly and inexpensively. Single feature maps for characteristics such as drainage, texture of surface deposits, slope, and stoniness are examples. In addition, maps showing the sixteen engineering and recreational use interpretations that are provided in tabular form in Part 4 of this report can be derived from the basic soil map.

PART 3

DEVELOPMENT, CLASSIFICATION AND DESCRIPTION OF SOILS

This section describes the important characteristics of the soils and their relationship to the factors of soil development.

3.1 SOIL DEVELOPMENT

The principal factors affecting soil formation are climate, vegetation, parent material, relief, and drainage. The type of soil found at any one place is dependent upon the interaction of these factors, the length of time they have been operative, and the modifications resulting from the work of man.

A soil that comes into equilibrium with its environment develops characteristics and morphology unique to itself and is considered a mature soil. When viewed in vertical cross-section, a mature soil is seen to consist of various layers called soil horizons. The main or master horizons have been designated by the letters O, L, F, H for organic layers and A, B, C for mineral horizons[6]. Lower case suffixes are used to indicate the type of master horizons and arabic numerals are used when further subdivision into subhorizons are required. If the soil profile is developed from nonconforming parent materials, common numeral prefixes are used to indicate lithologic changes. Table 4 presents a hypothetical soil profile showing all principle horizons. The master horizon symbols and lower case letter suffixes are defined in more detail in the Glossary.

The A and B horizons are a reflection of the genetic forces operating on the parent material and together they are termed the solum of the soil. No simple definition of master horizons is possible since there are so many different kinds. In general, A horizons or surface layers are subjected to the greatest amount of weathering and leaching and/or organic matter accumulation. The B horizons, lying immediately below the A horizon, contain most of the material leached from the A horizons or have been otherwise altered by soil forming processes. The C horizons represent the relatively unweathered parent material from which the solum has developed.

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[6] Canada Soil Survey Committee, Subcommittee on Soil Classification. 1978. The Canadian System of Soil Classification. Can. Dept. Agric. Publ. 1646.

Table 4. A Hypothetical Soil Profile Showing All Principal Horizons+

L, F, H Organic debris lodged on soil developed under forest, usually absent on soils developed under grasses.	L	Loose leaves and organic debris, largely undecomposed
	F	Organic debris, partially decomposed or matted
	H	Well decomposed organic matter, original structures indiscernible
A Horizons of maximum biological activity and maximum eluviation (removal of materials dissolved or suspended in water, or both).*	Ah	A dark colored horizon with a high content of organic matter mixed with mineral matter
	Ae	A light colored horizon of maximum eluviation. Prominent in Luvisolic and Podzolic soils; faintly developed or absent in Chernozemic and Brunisolic soils
	AB	Transitional to B, but more like A than B. Sometimes absent
B Horizons of illuviation (of accumulation of suspended material from A) or of maximum clay accumulation, or of blocky or prismatic structure, or both.*	BA	Transitional to A, but more like B than A. Sometimes absent
	Bm	Alteration due to hydrolysis or oxidation to give a change in color or structure as in Chernozemic soils
	Bmy	Like Bm but strongly disrupted by frost action
	Bt	Maximum enrichment of clay minerals as in Luvisolic soils
	Btj	Insufficient clay enrichment to qualify for Bt
	Bn	Maximum development of prismatic structure as in Solonetzic soils
	Bfh	Maximum enrichment of iron and organic matter as in Podzolic soils
	BC	Transitional to C
C The soil parent material. Occasionally absent, i.e. soil building may have extended to a stratum other than bedrock, and of distinctly di ferent character from that in which the solum is found.	Cg	Denotes strongly gleyed horizons as in Gleysolic soils
	Cca	Accumulation of calcium carbonate
	Csa	Accumulation of soluble salts other than calcium carbonate
	Ck	Denotes presence of carbonate
	Cz	Frozen layer
Consolidated bedrock.	R	

+ It should be noted that not all of these horizons occur in any one soil profile.
* A and B represent the Solum, the genetic soil developed by soil-forming processes.
Source: Principles and Practices of Commercial Farming, 1977.

3.2 SOIL CLASSIFICATION

In the South Riding Mountain Planning District, the degree of soil development is related to the regional climate and the degree of leaching, translocation and accumulation of soluble and colloidal fractions of the soil. The soils have developed under a cool to cold subhumid Boreal climate which generally provides sufficient moisture and length of growing season to support vegetation of mixed woods, dominantly aspen and white spruce on the better drained landscapes and sedges, grasses and black spruce in the poorly drained landscapes. The dominant soils, because of such factors, are Luvisols and Dark Gray Chernozems on the better drained sites. These soils have characteristic leached surface horizons (Ap, Ahe or Ae horizons), and an accumulation zone (Btj or Bt horizon) containing translocated clay and organic matter.

Poor drainage associated with depressional areas causes the soil environment to change from an oxidative state to a depleted oxygen or reductive state. The characteristics of soils with restricted drainage are: dull (gleyed) soil colors, the presence of mottles of iron and manganese, the presence of lime carbonate near the surface, and a high water table.

Poorly drained mineral soils in the South Riding Mountain Planning District study area are dominantly Rego Humic Gleysols, having a thin, dark colored A horizon (Ahg) with an accumulation of organic matter, and no B horizon. They frequently have an accumulation of peat on the surface.

Very poorly drained depressional sites result in areas of accumulation of shallow and deep organic materials, dominantly Terric Mesisol and Typic Mesisol soils, respectively. Most organic parent materials are moderately decomposed (mesic), and are derived from woody forest peat or, where sedges and grasses predominate, non-woody mesic fen peat.

The soil parent material and profile type become the dominant features used in classifying and mapping soils; these features can be organized readily to show the relationship of parent material, soil type, drainage and series (see Table 6). A somewhat more convenient and more abbreviated reference on the relationship of soil series in the area to the soil subgroup, drainage and parent material is provided in Table 7.

Table 5. Legend for Soils of the South Riding Mountain Planning District

Soil Symbol	Soil Name	Soil Drainage	Dominant Surface Texture and Parent Material	Soil Classification	
				Subgroup	Phase
BAK	Banks	Well	Loam; moderate to strongly calcareous, fine loamy lacustrine deposits overlying moderate to strongly calcareous, fine loamy morainal till.	Orthic Dark Gray	
BNY	Bethany	Imperfect	Loamy fine sand; moderate to strongly calcareous, fine sandy to sandy skeletal beach and outwash deposits.	Gleyed Rego Black	Carbonated
BRO	Brenkon	Poor	Clay; weakly to moderately calcareous, clay textured, stone-free glaciolacustrine deposits.	Rego Humic Gleysol	
BWG	Bluewing	Well	Loamy fine sand; moderately to strongly calcareous, coarse to moderately coarse textured sandy lacustrine sediments.	Dark Gray Luvisol	
BYH	Boynham	Very Poor	Peat; deep, moderately well decomposed organic deposits derived from forest type vegetation overlying undifferentiated materials.	Typic Mesisol	
CAY	Cayer	Very Poor	Peat; thin, moderately decomposed organic deposits derived from fen type vegetation overlying medium to fine textured lacustrine deposits.	Terric Mesisol	Clay Substrate
DKS	Dickson	Imperfect	Fine sandy loam; moderately calcareous, coarse to moderately coarse textured sandy lacustrine deposits overlying moderately to strongly calcareous, fine loamy morainal till.	Gleyed Dark Gray	
DVD	Davidson	Well	Loamy sand; weak to moderately calcareous, coarse loamy to sandy textured lacustrine deposits.	Orthic Dark Gray	
ECK	Erickson	Well	Clay loam; moderate to strongly calcareous, medium to moderately fine textured morainal tills.	Orthic Dark Gray	
HEC	Heron Creek	Poor	Loamy fine sand; moderately to strongly calcareous, coarse textured gravelly deltaic, beach or outwash deposits.	Rego Humic Gleysol	
HRD	Herod	Well	Sandy loam; moderately calcareous, medium sand lacustrine deposits.	Orthic Black	
KNI	Katherine	Imperfect	Loamy fine sand; moderately to strongly calcareous, coarse textured gravelly deltaic, beach or outwash deposits.	Gleyed Dark Gray	
KIC	Kircro	Very Poor	Peat; thin, moderately decomposed organic deposits derived from fen type vegetation overlying coarse to moderately coarse textured lacustrine deposits.	Terric Mesisol	Sand Substrate
LSW	Lenswood	Imperfect	Fine sandy loam; moderately calcareous, coarse textured sandy deposits.	Gleyed Rego Black	Carbonated
MRC	Marsh	Very Poor	Undifferentiated (mainly fine loamy) mineral soil deposits.	Rego Humic Gleysol	Carbonated
MWK	Meadowbrook	Well	Clay; moderately to strongly calcareous, medium to moderately fine textured morainal till.	Orthic Dark Gray	
OKO	Okno	Very Poor	Peat; thin, moderately decomposed organic deposits derived from forest type vegetation overlying moderately calcareous, medium to fine textured lacustrine deposits.	Terric Mesisol	Clay Substrate

Soil Symbol	Soil Name	Soil Drainage	Dominant Surface Texture and Parent Material	Soil Classification	
				Subgroup	Phase
OOL	Omemee	Well	Loam; moderately to strongly calcareous, medium to moderately fine textured lacustrine deposits.	Orthic Dark Gray	
OSA	Osprey	Moderately Well	Sandy loam; moderate to strongly calcareous, coarse loamy lacustrine deposits overlying moderately to strongly calcareous, fine loamy morainal till.	Orthic Dark Gray	
PPL	Pappleton	Imperfect	Fine sandy loam; moderately calcareous, coarse to moderately coarse textured sandy lacustrine deposits.		
PTU	Petlura	Imperfect	Loam; moderate to strongly calcareous, fine loamy, stony, morainal till.	Gleyed Dark Gray	
PVK	Proven Lake	Poor	Clay loam; moderately calcareous, moderately fine textured stratified lacustrine deposits	Rego Humic Gleysol	
PVK(p)	Proven Lake	Very Poor	Peat; thin, mesic peat, overlying moderately calcareous, moderately fine textured stratified lacustrine deposits.	Rego Humic Gleysol	Peaty
RBN	Rublin	Poor	Loam; weakly to moderately calcareous, fine loamy to clayey deposits in depressional areas of fine loamy morainal till.	Humic Luvic Gleysol	
RKH	Rackham	Well	Fine sandy loam; moderately to strongly calcareous, medium to moderately fine textured lacustrine deposits	Orthic Gray Luvisol	
RTV	Rat River	Very Poor	Peat; moderately decomposed organic deposits derived from forest type vegetation overlying weakly to moderately calcareous sandy glacio-fluvial deposits.	Terric Mesisol	Sand Substrate
SSB	Sand Beach	Rapid to Poor	Fine to medium sand; weakly to moderately calcareous stratified sandy to gravelly water sorted shore line deposits of variable thickness.	Gleyed Regosol	
SWH	Seech	Well	Loamy fine sand; moderately to strongly calcareous, coarse sandy to coarse gravelly deltaic, beach or outwash deposits.	Calcareous Black	
SWH(c)	Seech classification variant	Well	See SWH	Orthic Dark Gray	
SMT	Sinnott	Poor	Clay loam; moderately to strongly calcareous, medium to moderately fine textured morainal till.	Rego Humic Gleysol	
SMT(p)	Sinnott	Very Poor	Peat; thin, mesic organic deposits overlying moderately to strongly calcareous, medium to moderately fine textured morainal till.	Rego Humic Gleysol	Peaty

Soil Symbol	Soil Name	Soil Drainage	Dominant Surface Texture and Parent Material	Soil Classification	
				Subgroup	Phase
STD	Stead	Very Poor	Peat; deep, moderately to well decomposed organic deposits derived from fen type vegetation overlying undifferentiated materials.	Typic Mesisol	
SWF	Swanford	Imperfect	Fine sandy loam; moderately to strongly calcareous, medium to moderately fine textured lacustrine deposits.	Gleyed Rego Black	Carbonated
SWN	Swan	Imperfect	Loam; moderately to strongly calcareous, medium to moderately fine textured lacustrine deposits	Gleyed Dark Gray	
TUE	Two Lake	Imperfect	Clay loam; moderately to strongly calcareous fine loamy, stony, morainal till.	Gleyed Gray Luvisol	
VLY	Valley	Imperfect	Loam; moderately to strongly calcareous, medium to moderately fine textured lacustrine deposits	Gleyed Rego Black	Carbonated
VUT	Vista	Poor	Fine sandy loam; moderately calcareous, coarse textured sandy deposits.	Rego Humic Gleysol	
VUT(p)	Vista	Very Poor	Peat; thin, mesic peat, overlying moderately calcareous, coarse textured sandy deposits.	Rego Humic Gleysol	Peaty
WLM	Wallman	Imperfect	Clay; moderately to strongly calcareous, medium to moderately fine textured morainal till.	Gleyed Dark Gray	
WTU	Watus	Well	Fine sandy loam to clay loam; non to weakly calcareous, thin coarse textured morainal till overlying weathered shale.	Orthic Gray Luvisol	
WTV	Waitville	Well	Loam; moderately to strongly calcareous, stony, medium to moderately fine textured morainal till.	Orthic Gray Luvisol	
ZAP	Zaporozhe	Well	Loamy fine sand; extremely calcareous, coarse sandy to gravelly deltaic, beach or outwash deposits.	Orthic Gray Luvisol	

Table 6. Parent Materials, Soils and Their Estimated Extent in the South Riding Mountain Planning District Area

	Map Symbol	Total Ha	% of Area
1. Morainal till parent material.			
Soils developed on:			
.1 Deep (>1 m) moderately to strongly calcareous, medium to moderately fine (fine loamy) textured morainal till derived from shale, limestone and granitic rocks.			
a) Well drained			
Waitville series (Orthic Gray Luvisol)	WTV	3,242	11.8
Erickson series (Orthic Dark Gray)	ECK	4,298	15.6
b) Imperfectly drained			
Tee Lake series (Gleyed Gray Luvisol)	TEK	165	0.6
Petiura series (Gleyed Dark Gray)	PTU	639	2.3
c) Poorly drained			
Sinnott series (Rego Humic Gleysol)	SNT	379	1.4
Sinnott series, peaty phase	SNTp	313	1.1
Roblin series (Humic Luvic Gleysol)	RBN	34	0.1
	Subtotal		32.9
.2 Deep (>1 m) moderately calcareous, fine textured (clayey) morainal till derived primarily from shale clay origin. Inclusions of limestone pebbles and cobbles are common.			
a) Well drained			
Wapus series (Orthic Gray Luvisol)	WPU	8	.1
Meadowbrook series (Orthic Dark Gray)	MWK	1,438	5.2
b) Imperfectly drained			
Wellman series (Gleyed Dark Gray)	WLM	104	0.4
c) Poorly drained			
Brecken series (Rego Humic Gleysol)	BKO	122	0.4
	BKOp	10	0.1
	Subtotal		6.1
2. Fluvial outwash parent materials.			
Soils developed on:			
.1 Deep (>1 m) coarse textured (sandy), strongly calcareous, gravelly deltaic, beach and outwash deposits.			

a) Well drained			
Zaparoza series (Orthic Gray Luvisol)	ZAP	873	3.1
Seech series (Calcareous Black)	SHH	1,680	6.1
Seech (c) series (Orthic Dark Gray)	SHH(c)	33	0.1
(Gravel Pits)		6	-
b) Imperfectly drained			
Katherine series (Gleyed Dark Gray)	KHI	152	0.5
Bethany series (Gleyed Rego Black)	BHY	91	0.3
Sand Beaches	SDB	25	0.1
c) Poorly drained			
Heron Creek (Rego Humic Gleysol)	HEC	267	1.0
	HECp	9	0.1
	Subtotal		11.3

3. Lacustrine parent materials.
Soils developed on:

.1 Deep (>1 m) moderately calcareous, coarse to moderately coarse (sandy-coarse loamy) textured sandy sediments.

a) Well drained			
Bluewing series (Dark Gray Luvisol)	BWG	281	1.0
Davidson series (Orthic Dark Gray)	DVD	1,600	5.9
Horod series (Orthic Black)	HRD	103	0.3
b) Imperfectly drained			
Poppleton series (Gleyed Dark Gray)	PPL	265	0.9
Lenswood series (Gleyed Rego Black)	LSW	215	0.8
c) Poorly drained			
Vista series (Rego Humic Gleysol)	VST	109	1.5
Vista series, peaty phase	VSTp	245	0.9

.2 Deep (>1 m) moderately to strongly calcareous, medium textured (loamy) lacustrine deposits.

a) Well drained			
Onanole series (Orthic Dark Gray)	OOL	590	2.1
b) Imperfectly drained			
Swanford series (Gleyed Rego Black)	SWF	212	0.8

.3 Deep (>1 m) moderately to strongly calcareous, moderately fine (fine loamy) textured lacustrine deposits.

a) Well drained			
Rackham series (Orthic Gray Luvisol)	RKH	866	3.1

b) Imperfect drained			
Swan series (Gleyed Dark Gray	SWN	269	1.0
Valley series (Gleyed Rego Black)	VLY	143	0.5
c) Poorly drained			
Proven Lake series (Rego Humic Gleysol)	PVK	340	1.2
Proven Lake series, peaty phase	PVKp	411	1.5
Marsh series (Rego Humic Gleysol)	MHC	129	0.5
	Subtotal		22.0

4. Lacustrine veneers on morainal till deposits (sandy/fine loamy).
Soils developed on:
.1 Thin (25 to 100 cm) moderately to strongly calcareous, coarse to moderately coarse textured, sandy sediments overlying moderately to strongly calcareous, medium to moderately fine textured morainal till derived from shale, limestone and granitic rocks.

a) Well drained			
Ozerna series (Orthic Dark Gray)	OZA	409	1.5
b) Imperfectly drained			
Dickson series (Gleyed Dark Gray)	DKS	307	1.1

.2 Thin (25 to 100 cm) moderately calcareous, medium textured lacustrine sediments overlying moderately to strongly calcareous, medium to moderately fine textured (loamy/fine loamy) morainal till derived from shale, limestone and granitic rocks.

a) Well drained			
Banks series (Orthic Dark Gray)	BAX	107	0.4
	Subtotal		3.0

5. Organic deposits.
Soils developed on:
.1 Mesic fen peat (>160 cm deep).

a) Very poorly drained			
Stead series (Typic Mesisol)	STD	361	1.3

.2 Mesic fen peat (40 to 160 cm) overlying moderately calcareous, medium to moderately fine textured lacustrine deposits.

a) Very poorly drained Cayer series (Terric Mesisol)	CAY	1,422	5.2
.3 Mesic fen peat (40 to 160 cm) overlying moderately calcareous, coarse textured sandy lacustrine deposits.			
a) Very poorly drained Kircro series (Terric Mesisol)	KIC	464	1.7
.4 Mesic forest peat (>160 cm).			
a) Very poorly drained Baynham series (Typic Mesisol)	BYH	86	0.3
.5 Mesic forest peat (40 to 160 cm) overlying moderately calcareous, medium to moderately fine textured lacustrine deposits.			
a) Very poorly drained Okno series (Terric Mesisol)	OKO	120	0.4
.6 Mesic forest peat (40 to 160 cm) overlying moderately calcareous, coarse textured sandy lacustrine deposits.			
a) Very poorly drained Rat River series (Terric Mesisol)	RTV	204	0.7
	Subtotal		9.6
Water bodies and lakes (ZZ)		4,062	14.9
	TOTAL	27,645	100%

Table 7. Relationship of the Soil Series in the South Riding Mountain Study Area to Soil Drainage, Subgroup and Parent Material.

		Parent Material								
		Glacial Till		Outwash		Lacustrine			Organic	
Drainage	Subgroup	Medium to Moderately Fine Texture	Fine Texture	Coarse Gravelly	Coarse to Moderately Coarse Texture	Medium to Moderately Fine Texture	Coarse to Moderately Coarse Glacial Till	Medium to Moderately Fine Glacial Till	Mesic Forest Peat	Mesic Fen Peat
Well to Moderately Well	Orthic Gray Luvisol	Waitville (WTV)	Wapus (WPU)	Zaparoza (ZAP)		Rackham (RKH)				
	Dark Gray Luvisol				Blue Wing (BWG)					
	Orthic Dark Gray	Erickson (ECK)	Meadowbrook (MWK)		Davidson (DVD)	Onanole (OOL)	Ozerna (OZA)	Banks (BAX)		
	Orthic Black			Horod (HRD)						
	Calcareous Black			Seech (SHH)						
Imperfect	Gleyed Gray Luvisol	Tee Lake (TEK)								
				Sand Beaches (SDB)						
	Gleyed Dark Gray	Petlura (PTU)	Wellman (WLM)	Katherine (KHI)	Poppleton (PPL)	Swan (SWN)	Dickson (DKS)			
	Gleyed Carbonated Rego Black			Bethany (BHY)	Lenswood (LSW)	Swanford (SWF) Valley (VLY)				
Poor	Humic Luvic Gleysol	Roblin (RBN)								
	Rego Humic Gleysol	Sinnott (SNT,SNTp)	Breckon (BKO)	Heron Creek (HEC)	Vista (VST,VSTp)	Proven Lake (PVK,PVKp) Marsh (MWC)				
Very Poor	Terric Mesisol				Kircro (KIC)* Rat River (RTV)				Okno (OKO)	Cayer (CAY)
	Typic Mesisol								Baynham (BYH)	Stead (STU)

* Kircro - Fen Peat, Rat River - Forest Peat

3.3 DESCRIPTION OF THE SOIL SERIES

The soil series of the South Riding Mountain Planning District study area are described in alphabetical order and include a general description of the genetic profile type, texture, parent material, topography and drainage. Further information on the suitability and management of each soil for agriculture, their engineering properties and their properties in relation to urban and recreational use is given in other sections of the report.

Banks Series (BAX)

The Banks series consists of well drained Orthic Dark Gray soil developed on shallow (25 to 100 cm), strongly to very strongly calcareous, uniform, loamy lacustrine deposits overlying very strongly calcareous loamy morainal deposits. These soils occur in upper to middle positions of very gentle to moderate slopes on level to undulating landscapes and have moderate permeability and slow surface runoff. There is no observable water table within one meter of the ground surface during the growing season. Banks soils are non to slightly eroded and may be slightly stony. They have medium available water holding capacity, and medium organic matter content. Native vegetation often includes aspen, shrubs, herbaceous plants, and grasses. The majority of these soils are currently used for annual crop production.

In a representative profile of Banks soil the solum is approximately 40 cm thick. The profile is characterized by a dark gray, loam textured Ap horizon, 10 to 30 cm thick, overlying a dark grayish brown, loam Bm horizon, 15 to 18 cm thick, with weak prismatic to moderate medium subangular blocky structure, a weakly mottled, grayish brown, sandy loam Ck horizon, of variable thickness grades to a more compact, light gray, strongly calcareous, clay loam textured 2Ck horizon, containing many coarse fragments.

Banks soils occur in close association with Erickson and Onanole soils. They are similar to Onanole soils by having the same surface and solum texture but differ from Onanole soils because of the presence of glacial till within one meter of the soil surface. Banks soils were previously included in areas mapped as Onanole Association in the reconnaissance soil report of the Rossburn Virden area.

Baynham Series (BYH)

The Baynham series consists of very poorly drained Typic Mesisol soil developed on deep (>160 cm) mesic forest peat overlying undifferentiated materials. These soils occur in depressions and in low lying areas of nearly level landscapes and have slow permeability very slow surface runoff and a very high water table during the growing season. Baynham soils are generally deficient in phosphorous, potassium and copper. They also have a significantly colder micro climate than adjacent mineral soils. Native vegetation often includes black spruce, shrubbs, labrador tea, and mixed mosses. The majority of these soils are currently not used and remain as natural grazing and as moderately productive woodland.

In a representative profile of a Baynham soil the organic material is generally more than 160 cm thick. The profile is characterized by a layered, light brown sphagnum and dark brown feather moss Of horizon, 15 to 30 cm thick, overlying a thick dark brown, moderately decomposed Om horizon, 60 to 120 cm thick, with nu-

merous inclusions of woody fragments. The underlying mineral soil is strongly reduced as indicated by the dark gray colors. A well decomposed humic layer of variable thickness commonly occurs at the contact of the mineral soil. The parent material is typically moderately decomposed forest peat. A typical profile often contains a series of layers of organic materials in various stages of decomposition.

Baynham soils often occur in close association with Okno and Rat River soils. They are similar to both these soils by having a similar origin and composition of organic materials but differ from both soils because of the greater thickness of organic deposits. Okno soils are underlain by clay within 160 cm of the surface while Rat River soils are underlain by sand within 160 cm of the surface. Baynham soils were previously mapped as undifferentiated peat of varying type and depth in the reconnaissance soil survey of the Rossburn Virden area.

Bethany Series (BHY)

The Bethany series consists of imperfectly drained carbonated, Gleyed Rego Black soil developed on shallow (25 to 100 cm) uniform, strongly calcareous, sandy fluvial outwash deposits. These soils occur in lower positions of very gentle slopes on undulating landscapes and have rapid permeability moderate to slow surface runoff and a medium high water table during the growing season. Bethany soils are non-eroded, slight to moderately stony and non-saline. They have low available water holding capacity, and medium to low organic matter content. Native vegetation often includes meadow grasses, shrubs, and willows. The majority of these soils are currently used for forage and some for annual crop production.

In a representative profile of Bethany soil the solum is approximately 28 cm thick. The profile is characterized by a black, sandy, strongly calcareous, Ahk (Apk) horizon, 15 to 25 cm thick, overlying a strongly calcareous, sandy transitional AC horizon, 5 to 10 cm thick, a very strongly calcareous, coarse sandy Cca horizon, 5 to 10 cm thick with few fine faint mottles, and a few coarse fragments, and a strongly calcareous, sandy Ckg horizon, 30 to 50 cm thick with many strong prominent mottles. The parent material is typically sandy to gravelly deltaic, beach and outwash deposits. Bethany soils occur in close association with Katherine and Seech soils. They are similar to these soils by having the same parent material but differ from Seech soils because of poorer drainage and from Katherine soils by the presence of carbonates throughout the profile. Bethany soils also have a higher and more persistent water table than either of these soils. Bethany soils were previously mapped as minor inclusions in the Seech Deep Phase Association in the Reconnaissance soil survey of the Rossburn Virden area.

Blue Wing Series (BWG)

The Blue Wing series consists of well drained Dark Gray Luvisol soil developed on deep (>100 cm) moderately to strongly calcareous, uniform, sandy lacustrine deposits. These soils occur in upper to middle positions of gently sloping, hummocky landscapes and have rapid permeability, moderately slow surface runoff and a low (>2 m) water table during the growing season. Blue Wing soils are susceptible to erosion and may be moderately eroded, non-stony and non-saline. They have low available water holding capacity, and low organic matter content. Native vegetation often includes white spruce, aspen,

shrubs, and grasses. The majority of these soils are currently used for improved pasture and forage.

In a representative profile of Blue Wing soil, the solum is approximately 67 cm thick. In the natural condition the profile is characterized by a thin slightly acidic leaf mat 3 to 5 cm thick, a dark gray Ahe horizon, 7 to 12 cm thick, and a light gray Ae horizon, 10 to 25 cm thick, with weak fine platey structure, a brown to dark brown, sandy loam textured Bt horizon, 18 to 25 cm thick with weak medium subangular blocky structure and a loamy sand transitional BC horizon, 25 to 30 cm thick, grading into a moderately calcareous, yellowish brown sandy Ck horizon. The parent material is typically stone free sand.

Blue Wing soils occur in close association with Davidson and Rackham soils. They are similar to Davidson and Poppleton soils by having similar parent materials, but differ from Rackham soils because of a lighter sandier texture, and from Poppleton soils because of better drainage. Blue Wing soils were previously included in the Rackham sandy loam Association as mapped in the reconnaissance soil survey of the Rossburn Virden Area.

Breckon Series (BKQ)

The Breckon series consists of poorly drained Rego Humic Gleysol soil developed on deep, (>100 cm) uniform, moderately calcareous, clay textured morainal deposits. These soils occur in depressional positions of nearly level to undulating landscapes and have very slow permeability, very slow surface runoff, and a medium high water table during the growing season. Breckon soils are non-eroded, non to slightly stony and non-saline. They have high available water holding capacity, and medium organic matter content. Native vegetation often includes sedges, reeds, willows, and meadow grasses. The majority of these soils are currently used for natural grazing and some for improved pasture.

In a representative profile of Breckon soil the solum is approximately 38 cm thick. The profile is characterized by a black, moderately calcareous, clayey Ahk horizon, 10 to 30 cm thick, overlying a massive, moderately calcareous, grayish brown Ckg horizon, with many medium prominent reddish brown mottles. The parent material is typically stone free. Breckon soils occur in close association with Meadowbrook soils. They have similar parent material but differ from Meadowbrook soils because of poorer drainage. Breckon soils were previously mapped in the Meadowbrook Association in the soil report for the Rossburn Virden Area.

Cayer Series (CAY)

The Cayer series consists of very poorly drained Terric Mesisol soil developed on shallow (40 to 160 cm) of moderately decomposed, herbaceous fen peat, overlying moderately to strongly calcareous, medium to fine textured deposits. These soils occur in depressions and low lying areas on nearly level to undulating landscapes and have moderate to slow permeability very slow surface runoff and a very high water table during the growing season. Native vegetation often includes sedges, meadow grasses, shrubbs, and mosses. Cayer soils tend to be deficient in phosphorous, potassium and copper. They also have a significantly colder micro climate than adjacent mineral soils. The majority of these soils are not currently used although some in the vicinity of Erickson have been

developed for forages and annual crops.

In a representative profile of Cayer soil the organic material is approximately 40 to 160 cm thick. The profile is characterized by reddish brown, moderately decomposed Om layer, overlying fine loamy to clayey lacustrine deposits. The organic Om layer commonly has a number of layers showing an increasing degree of decomposition of the organic material with depth. The most humified layer occurs at the mineral soil contact.

Cayer soils occur in close association with Stead and Kircro soils. They are similar to both these soils by having a similar composition of fen peat but differ from Stead soils because of their shallow thickness to mineral soil and from Kircro soils because of the sandy texture of the underlying mineral soil of the Kircro series. Cayer soils were previously mapped as undifferentiated peat of variable type and thickness in the reconnaissance soil survey of the Rossburn Virden area.

Davidson Series (DVD)

The Davidson series consists of well drained Orthic Dark Gray soil developed on deep (>100 cm) weak to moderately calcareous, coarse loamy, lacustrine deposits. These soils occur in middle to upper slope positions on gently sloping hummocky landscapes and have rapid permeability moderate surface runoff and a moderately low water table during the growing season. Davidson soils are susceptible to water erosion, and are slightly wind eroded, non-stony and non-saline. They have low available water holding capacity, and low organic matter content. Native vegetation often includes aspen, shrubs, and grasses. The majority of these soils are currently used for annual crop production and forages, while those on steeper more erodible slopes are used for natural grazing and improved pasture.

In a representative profile of Davidson soil the solum is approximately 59 cm thick. The profile is characterized by a dark gray loamy sand, Ap or Ahe horizon, 13 to 20 cm thick, a dark yellowish brown, sandy loam Bt horizon, 10 to 20 cm thick, with very weak blocky structure, and a grayish brown moderately calcareous, sandy Ck horizon, 20 to 40 cm thick with loose single grain structure and abundant coarse fragments. The parent material is typically sandy and stratified.

Davidson soils occur in close association with Ozerna and Poppleton soils. They are similar to these soils by having the same textural range but differ from Poppleton soils because of better drainage and from Ozerna soils by the lack of a till contact within one meter of the surface. Davidson soils were previously included in the Rackham soil Association as mapped in the reconnaissance soil survey of the Rossburn Virden area.

Dickson Series (DKS)

The Dickson series consists of imperfectly drained Gleyed Dark Gray soil developed on a mantle (25 to 100 cm) of moderately calcareous, coarse to moderately coarse textured sandy lacustrine deposits, overlying moderately to strongly calcareous, fine loamy morainal deposits. These soils occur in middle and lower positions of nearly level to undulating landscapes and have moderate permeability moderately slow surface runoff and a medium low water table during the growing season. Dickson soils are not easily eroded, non-stony and non-saline. They have low available water holding capacity, and low organic

matter content. Native vegetation often includes trembling aspen, birch, balsam poplar, willow, and grasses. The majority of these soils are currently used for forages and annual crop production.

In a representative profile of Dickson soil the solum is approximately 54 cm thick. The profile is characterized by a gray to dark gray, sandy loam textured Ap horizon, 12 to 20 cm thick, overlying a gray to light gray, loamy fine sand Ahe-Ahegj horizon, 15 to 40 cm thick, with few fine faint, reddish mottles, a brownish sandy loam Bmgj horizon, 12 to 36 cm thick with weak subangular blocky structure, and few medium faint mottles, a thin transitional BC horizon, 10 to 15 cm thick with some coarse fragments grades to a fine loamy 2Ckgj horizon. The parent material is typically sandy to coarse loamy overlying fine loamy morainal deposits. The mottling in the profile is likely the result of restricted drainage caused by the close proximity of the underlying till.

Dickson soils occur in close association with Davidson, Ozerna, and Poppleton soils. They are similar to Poppleton soils in drainage and texture but differ from them because of the shallow depth to compact till. Dickson soils differ from Davidson soils because of poorer drainage and shallow depth to till and from Ozerna soils because of poorer drainage. Dickson soils were previously mapped in the Rackham Soil Association in the reconnaissance soil survey of the Rossburn Virden area.

Erickson Series (ECK)

The Erickson series consists of well drained Orthic Dark Gray soil developed on deep (>100 cm) moderately calcareous, loamy to fine loamy morainal deposits. These soils occur in middle to upper positions of gently sloping, hummocky landscapes and have moderately slow permeability, moderately rapid surface runoff, and a medium low (>2m) water table during the growing season. Erickson soils are moderately susceptible to both wind and water erosion, many are moderately eroded, slightly to moderately stony and non-saline. They have medium available water holding capacity, and medium to high organic matter content. Native vegetation often includes aspen with a thick under growth of shrubs, herbaceous plants and grasses. The majority of these soils are currently used for annual crop production.

In a representative profile of Erickson soil the solum is approximately 33 cm thick. The profile is characterized by dark gray loamy Ap horizon, 10 to 15 cm thick, with inclusions of coarse fragments and cobbles, a dark yellowish brown clayloam to light clay Bt horizon, 20 to 30 cm thick, with weak medium subangular structure, and a variable transition BC horizon, 10 to 15 cm thick. A pale brown, extremely calcareous, loamy textured lime accumulation zone (Cca horizon) is often present just above the light yellowish brown, moderately to strongly calcareaous Ck horizon. The parent material is glacial till derived from a mixture of cretaceous shales, precambrian granitic rocks and paleozoic limestones and dolomites. A typical profile contains coarse fragments throughout.

Erickson soils occur in close association with Petlura, Sinnot and Roblin soils. They are similar to these soils by having similar texture and parent material but differ from

all of these soils because of better drainage. Petlura soils are imperfectly drained, while Sinnot and Roblin soils are poorly drained. Erickson soils were previously mapped as the Erickson soil Association in the reconnaissance survey of soils in the Rossburn Virden area.

Heron Creek Series (HBC)

The Heron Creek series consists of poorly drained Rego Humic Gleysol soil developed on deep (>100 cm) moderately to strongly calcareous, coarse textured gravelly deltaic beach or outwash deposits. These soils occur in depressions of level to nearly level landscapes and have high permeability, moderately slow surface runoff and a high water table during the growing season. Heron Creek soils associated with creek or stream channels are susceptible to water erosion by stream flow if the soil surface is broken or disturbed. Many of these soils are moderately stony and all are non-saline. Heron Creek soils have low available water holding capacity, and medium organic matter content. Native vegetation often includes reeds, sedges, cattails and willow. The majority of these soils are currently used for natural grazing and woodland.

In a representative profile of Heron Creek soil the solum is approximately 25 cm thick. The profile is characterized by a black, strongly calcareous, sandy loam Ahk horizon, 20 to 40 cm thick, overlying a strongly mottled, strongly calcareous, coarse gravelly Ckg horizon, a thin transitional AC horizon is common between the A and C horizons. The parent material is typically stratified, a legacy of its fluvial origin. A typical profile generally contains stones and cobbles.

Heron Creek soils occur in close association with Sinnot and Seech soils. They are similar in texture to Seech soils but differ significantly due to their poorer drainage. They differ from Sinnot soils because of their coarse textured parent material. Heron Creek soils were not previously differentiated. They were considered as inclusions of Seech and Zaparosa soil Associations, and some were included in the Peat and Half Bog map units in the reconnaissance survey of soils in the Rossburn Virden area.

Horod Series (HRD)

The Horod series consists of moderately well drained Orthic Black soil developed on deep (>100 cm) moderately to strongly calcareous, sandy to coarse loamy, fluvial deposits. These soils occur in upper and midslope positions of nearly level to gently sloping landscapes and have rapid permeability, moderately slow surface runoff and a medium low water table during the growing season. Horod soils are slightly eroded because of their susceptibility to water and wind erosion, non-stony and non- saline. They have low available water holding capacity, and medium to low organic matter content. Native vegetation often includes aspen, shrubs, and grasses. The majority of these soils are currently used for annual crop production.

In a representative profile of Horod soil the solum is approximately 30 cm thick. The profile is characterized by black, sandy loam Ap horizon, 15 to 20 cm thick, a dark grayish brown, sandy loam Bm horizon, 10 to 15 cm thick, overlying a thin, gray, strongly calcareous Cca horizon, 5 to 10 cm thick, and a strongly calcareous, grayish brown, single grained,loamy sand Ckgj horizon, with

many fine faint mottles. A typical profile may contain some coarse fragments and infilled gopher burrows.

Horod soils occur in close association with Lenswood soils. They are similar in texture and parent materials but differ from each other because of drainage and level of carbonates throughout the profile. Horod soils are more leached and better drained than Lenswood soils. Horod soils were previously mapped as the Horod Soil Association in the reconnaissance survey of soils in the Rossburn Virden area.

Katherine Series (KHI)

The Katherine series consists of imperfectly drained Gleyed Dark Gray soil developed on deep (>100 cm), moderately to strongly calcareous, coarse textured, sandy to gravelly, deltaic, beach, or outwash deposits. These soils occur in mid to lower positions of very gentle to moderate slopes on undulating to hummocky landscapes and have rapid permeability, moderately slow surface runoff and a generally low water table during the growing season. Katherine soils are susceptible to wind erosion when cultivated, and are non- to slightly stony and non-saline. They have low available water holding capacity, and medium organic matter content. Native vegetation often includes aspen, willow, shrubs, and grasses. The majority of these soils are currently used for improved pasture and annual crop production.

In a representative profile of Katherine soil the solum is approximately 50 cm thick. The profile is characterized by a dark gray, sandy loam Ah or Ap horizon, 15 to 20 cm thick, grading gradually to a gray, sandy loam, Ahe horizon, 4 to 10 cm thick, overlying a grayish brown to brown sandy loam to sandy clay loam Btgj horizon, 20 to 35 cm thick with many medium faint reddish and yellowish mottles and iron stains. The underlying Ckg horizon, is moderately calcareous and has a coarse sandy texture, with many medium prominent reddish brown mottles, and many coarse fragments. The parent material is typically stratified with sandy to gravelly layers which reflect its fluvial origin. A typical profile may contain coarse fragments of shale, granitic rock, limestone and dolomite throughout.

Katherine soils occur in close association with Seech, Bethany and Poppleton soils. They have similar parent materials to Seech and Bethany soils but are more poorly drained than Seech soils and more leached than Bethany soils because of their relatively higher position in the landscape. Coarser texture differentiates Katherine soils from Poppleton soils. Katherine soils were previously included in areas mapped as Seech and Zaparosa soil Associations in the reconnaissance survey of soils in the Rossburn Virden areas.

Kircro Series (KIC)

The Kircro series consists of very poorly drained Terric Mesisol soil developed on shallow (40 to 160 cm) moderately decomposed fen type organic material overlying moderately calcareous sandy textured lacustrine deposits. These soils occur in depressions and low lying areas of nearly level to undulating landscapes and have slow to moderate permeability, very slow surface runoff and a very high water table during the growing season. Kircro soils have high available water holding capacity, high organic matter content, and generally are very deficient in phosphorous, potassium and copper. They also have a significantly colder micro-climate than adjacent mineral

soils. Native vegetation often includes sedges, aquatic mosses, and grasses, with isolated occurrences of willow, alder and swamp birch. The majority of these soils are currently used for natural grazing.

In a representative profile of Kircro soil the profile is characterized by a thin layer of fibric organic material, Of horizon 20 to 40 cm thick, a moderately decomposed Om (mesic) horizon, 50 to 80 cm thick, and an underlying moderately to very strongly calcareous sandy textured mineral contact within 160 cm of the ground surface. These soils are quite uniform becoming gradually more decomposed and more dense with depth.

Kircro soils occur in close association with Rat River and Vista peaty phase soils. They are similar to Rat River soils by having a calcareous coarse textured substrate but differ from Rat River soils because of the composition and origin of the peat. Kircro soils differ from Vista peaty phase soils by having a depth of organic material in excess of 40 cm overlying sand. Kircro soils were previously mapped as undifferentiated peat and half Bog soils of variable type and depth in the reconnaissance survey of soils in the Rossburn Virden area.

Lenswood Series (LSW)

The Lenswood series consists of imperfectly drained carbonated gleyed Rego Black soil developed on deep (>100 cm) moderately calcareous, sandy textured lacustrine deposits. These soils occur in middle to lower positions of gentle slopes on nearly level to gently undulating landscapes and have moderately rapid permeability, slow surface runoff and a medium high water table during the growing season. Lenswood soils are susceptable to wind erosion if left unprotected by excessive tillage. In this study Lenswood soils are slightly eroded, generally non- stony and non-saline. They have low available water holding capacity, and low to medium organic matter content. Native vegetation often includes aspen, balsam poplar, willow and grasses. The majority of these soils are currently used for annual crop production.

In a representative profile of Lenswood soil the solum is approximately 35 cm thick. The profile is characterized by a Black to very Dark Gray, strongly calcareous, sandy loam Apk horizon, 15 to 25 cm thick, a thin sandy loam transitional AC horizon, 10 to 15 cm thick, a lighter colored silty loam lime accumulation, Cca horizon, 5 to 15 cm thick with weak mottling and a grayish brown, single grained, sandy Ckg horizon, with many strong brown mottles and iron stains.

Lenswood soils occur in close association with Horod and Vista soils. They are similar to these two soils by having a similar range of texture but differ from Horod soils because of imperfect drainage and higher carbonate levels in the profile, and from Vista soils which have poor drainage. Lenswood soils were previously included in areas mapped as Seech (deep phase) sandy loam and Onanole (fine sandy loam) Associations in the reconnaissance survey of soils in the Rossburn Virden area.

Marsh Series (MSH)

The Marsh series consists of very poorly drained carbonated Rego Humic Gleysol soil developed on undifferentiated materials which can range from lacustrine clay to thin peaty and mucky loam deposits. These soils occur in level to depressional areas that are often covered with water or at least saturated for most of the growing season. Marsh soils generally have a low permeability, virtually

no surface runoff and a very high water table during the growing season. Marsh soils are seldom eroded, may be occasionally stony and in this study non-saline. They have high available water holding capacity, and high organic matter content. Native vegetation often includes reeds, sedges, and cattails, with willows and shrubs around the outer edges. The majority of these soils are currently under natural wetland vegetation and provide habitat for birds and other wildlife.

In a representative profile of Marsh soil in this study, the solum is relatively thick. The profile is characterized by a thin layer of either muck or mineral material high in organic matter content. The surface O or Ahkg horizon, may be as much as 50 cm thick, with carbonates and snail shells as common inclusions. The underlying olive gray Ckg horizon is strongly gleyed, with distinct mottles, and strongly calcareous. The parent material is typically derived from a mixture of lacustrine deposits and organic materials with depositional sediments blown in by wind and/or washed in as a result of surface runoff. Marsh soils are undifferentiated with respect to texture and composition of their parent material . They are also more poorly drained than other gleysolic soils.

Marsh soils occur in close association with gleysolic soils and permanent water bodies. Marsh soils were previously mapped as miscellaneous marsh and peaty meadow soils in the reconnaissance survey of soils in the Rossburn Virden area.

Meadowbrook Series (MDW)

The Meadowbrook series consists of well drained Orthic Dark Gray soil developed on deep (>100 cm), moderately to strongly calcareous, clayey textured morainal till deposits derived predominantly from Cretaceous shales. These soils occur in upper to middle positions of gently sloping to hummocky landscapes and have very slow permeability moderately, rapid surface runoff and a low water table during the growing season. Meadowbrook soils are slightly eroded, slightly stony and non-saline. They have clayey, cloddy surface horizons, high available water holding capacity, and medium organic matter content. Native vegetation often includes aspen, shrubs, herbaceous plants, and grasses. The majority of these soils are currently used for annual crop production.

In a representative profile of Meadowbrook soil the solum is approximately 37 cm thick. The profile is characterized by dark gray clay textured Ap horizon, 10 to 20 cm thick, a medium to strong subangular blocky, dark grayish brown clay textured Bt horizon, 15 to 25 cm thick. The lower portion of the profile has a grayish brown clayey BC horizon, 10 to 15 cm thick with some carbonates and faint mottling, and a strongly calcareous, gray massive clayey Ckgj horizon, with many medium prominent mottles. The parent material is typically clay. A typical profile also contains occasional coarse fragments and cobbles.

Meadowbrook soils occur in close association with Brecken soils by having a similar texture and parent material but differ from Brecken soils because of higher topographic position and therefore better drainage. Meadowbrook soils differ from Erickson soils by their heavier clay texture. Meadowbrook soils were pre-

viously mapped as Meadowbrook Soil Association in the reconnaissance survey of soils in the Rossburn Virden area.

Okno Series (OKO)

The Okno series consists of very poorly drained Terric Mesisol soil developed on shallow (40 to 160 cm) moderately decomposed, Mesic forest peat overlying moderately calcareous, loamy to fine loamy lacustrine deposits. These soils occur in level to depressional positions on nearly level to gently sloping landscapes and have moderate permeability, slow surface runoff and a very high water table during the growing season. Okno soils are non-eroded, non-stony and non-saline. They have high available water holding capacity, high organic matter content, and generally are very deficient in phosphorous, potassium and copper. They also have a significantly colder micro-climate than adjacent mineral soils. Native vegetation often includes black spruce, labrador tea, and other ericaceous shrubs and a ground cover of feather mosses and sphagnum. The majority of these soils are currently used as natural wetland habitat.

In a representative profile of Okno soil the organic materials are approximately 70 cm thick. The profile is characterized by a thin (<30 cm) discontinuous layer of fibric sphagnum moss overlying the woody mesic forest peat. The mesic peat often contains numerous layers of variable stages of decomposition and with variable content of woody fragments. Moderately to strongly calcareous loamy to clayey lacustrine sediments occur within 160 cm of the soil surface.

Okno soils occur in close association with Baynham and Proven Lake peaty phase soils. They are similar to Baynham soils by having a similar organic matter origin and composition of parent material but differ from Baynham soils because of their shallower thickness of peat. Proven Lake peaty phase soils are not as poorly drained and have only a very thin (<40 cm) layer of organic material. Okno soils were previously mapped as undifferentiated Peat and Half Bog soils of variable type and depth in the reconnaissance survey of soils in the Rossburn Virden area.

Onanole Series (OOL)

The Onanole series consists of well drained Orthic Dark Gray soil developed on deep (>100 cm), moderately to strongly calcareous, loam to fine loamy lacustrine deposits. These soils occur in middle and upper positions of gently sloping to hummocky landscapes and have moderate permeability, moderate surface runoff and a low water table during the growing season. Onanole soils are moderately susceptable to both wind and water erosion if steep slopes are left unprotected by cultivation. Typical Onanole soils are slightly eroded, non-stony and non-saline. They have medium available water holding capacity, and medium to low organic matter content. Native vegetation often includes aspen with a dense under growth of hazel, rose, saskatoon, shrubs and grasses. The majority of these soils are currently used for annual crop production.

In a representative profile of Onanole soil the solum is approximately 48 cm thick. The profile is characterized by a dark gray loam Ap-Ahe horizon, 10 to 18 cm thick, a dark grayish brown Bm or Bt horizon, 12 to 22 cm thick, with moderate medium prismatic to subangular blocky structure, a transition BC horizon, and/or

a lime accumulation Cca horizon 10 to 15 cm thick may be present between the B and the underlying strongly calcareous Ck horizon. The depth of the profile is variable depending on slope position with thinner profiles on steeper slopes. The average solum thickness in this study was 48.5 cm and the average A horizon thickness was 19.9 cm.

Onanole soils occur in close association with Rackham and Swanford soils. They are similar in texture to Swanford soils but have better drainage. The Chernozemic Onanole soils differ from the Luvisolic Rackham soils because of higher organic matter and clay content in their surface horizons. Onanole soils were previously mapped as Onanole Association in the reconnaissance survey of soils in the Rossburn Virden area.

Ozerna Series (OZA)

The Ozerna series consists of moderately well drained Orthic Dark Gray soil developed on thin (25 to 100 cm), moderately to strongly calcareous, coarse loamy lacustrine deposits overlying moderately to strongly calcareous fine loamy morainal deposits derived from shales, limestones and granitic rocks. These soils occur in middle to upper slope positions of nearly level to gently undulating landscapes and have moderate permeability, moderately slow surface runoff and a low water table during the growing season. Ozerna soils are susceptible to erosion if unprotected, and are usually non-stony and non-saline. They have medium available water holding capacity, and medium organic matter content. Native vegetation often includes aspen, herbaceous shrubs, and grasses. The majority of these soils are currently used for annual crop production.

In a representative profile of Ozerna soil the solum is approximately 56 cm thick. The profile is characterized by a dark grayish brown sandy loam AP - Ah horizon, 15 to 25 cm thick, a dark brown sandy loam to sandy clay loam Bm - Bt horizon, 20 to 25 cm thick, with weak medium subangular blocky structure, a slightly coarser textured strongly calcareous, loamy sand to sandy loam Ck horizon, overlays a more compact, fine loamy 2Ck horizon. A typical profile contains many coarse fragments at and below the contact of the 2Ck horizon.

Ozerna soils occur in close association with Davidson soils. They are similar to Davidson soils by having a similar range of surface texture and drainage but differ from Davidson soils because of the proximity of till within one meter of the soil surface. Ozerna soils were previously included and mapped as Rackham fine sandy loam and Waiteville transition soils in the reconnaissance survey of soils in the Rossburn Virden area.

Petlura Series (PTU)

The Petlura series consists of imperfectly drained Gleyed Dark Gray soil developed on deep (>100 cm), moderately to strongly calcareous, fine loamy morainal till derived from cretaceous shales, paleozoic limestones and dolomites and precambrian granitic rocks. These soils occur in middle to lower slope positions in undulating to hummocky landscapes and have moderate permeability, moderate surface runoff and a medium deep water table during the growing season. Petlura soils are slightly eroded slightly stony and non-saline. They have medium high available water holding capacity and medium organic matter content. Native vegetation often includes aspen, balsam poplar,

willows and herbaceous plants and grasses. The majority of these soils are currently used for annual crop production.

In a representative profile of Petlura soil the solum is approximately 50 cm thick. The profile is characterized by a dark gray granular, loamy Ap - Ahe horizon, 10 to 25 cm thick, a dark grayish brown, medium subangular blocky, clay loam Bt or Btgj horizon, 20 to 35 cm thick, with few medium faint mottles in the lower portion, a thin transitional BC or Cca horizon, 10 to 15 cm thick may commonly occur between the Bt and the underlying Ck horizon. The parent material is typically strongly calcareous and loam to clay loam in texture.

Petlura soils occur in close association with Erickson, Sinnot and Roblin soils. They are similar to these soils by having a similar parent material but differ from the well drained Erickson soils because of a higher moisture status and imperfect drainage, and from the poorly drained Sinnot and Roblin soils because of their better natural drainage.

Petlura soils were previously mapped as the Degrading Black Earth - meadow associates in the Erickson soil Association in the reconnaissance survey of the soils in the Rossburn Virden area.

Poppleton Series (PPL)

The Poppleton series consists of imperfectly drained Gleyed Dark Gray soil developed on deep (>100 cm), moderately calcareous, sandy to coarse loamy lacustrine deposits. These soils occur in middle to lower positions of very gently sloping, undulating landscapes and have rapid permeability, slow surface runoff and a meduim high water table during the growing season. Poppleton soils are slightly eroded, non-stony and non-saline. They have low available water holding capacity and medium organic matter content. Native vegetation often includes trembling aspen, birch, balsam poplar, and willow. The majority of these soils are currently used for annual crop production.

In a representative profile of Poppleton soil, the solum is approximately 50 cm thick. The profile is characterized by Dark Gray loamy sand, Ap horizon 15 to 25 cm thick, overlying a gray sandy Ahe horizon, 25 to 40 cm thick, a grayish brown sandy loam Bt horizon, 30 to 80 cm thick with many medium prominent mottles and a yellowish brown, moderately calcareous, mottled sandy Ck horizon. Till may occur within close proximity below one meter depth which can restrict drainage and account for some of the iron mottles in the lower part of the profile. The parent material is typically stone free sand.

Poppleton soils occur in close association with Vista and Davidson soils. They are similar to both soils by having a similar range of texture and parent material but differ from both soils because of better and poorer drainage respectively. Poppleton soils were previously mapped as inclusions in the Seech deep phase Association in the reconnassance soil survey of the Rossburn Virden area.

Proven Lake Series (PVK)

The Proven Lake series consists of poor to very poorly drained Rego Humic Gleysol soil developed on moderately calcareous, fine loamy stratified glaciolacustrine deposits. These soils occur in depressions of nearly

level to very gently sloping landscapes and have moderate permeability, slow surface runoff and a very high water table during the growing season. Proven Lake soils are non-eroded, non-stony and non-saline. They have high available water holding capacity, and high organic matter content. Native vegetation often includes sedges, reeds, willows, and meadow grasses. The majority of these soils are currently used for natural wetland habitat.

In a representative profile of Proven Lake soil the solum is approximately 34 cm thick. The profile is characterized by a dark gray to very dark gray, loam to clay loam Apk - Ahk horizon, 15 to 25 cm thick, a thin dark gray transitional AC horizon, 5 to 10 cm thick, with some fine faint mottles and carbonates, a strongly mottled, strongly calcareous, loam to clay loam Ckg horizon. In some locations a thin (<40 cm) layer of moderately decomposed peat may occur on the surface. These areas are mapped as Proven Lake peaty phase soils. The parent material is typically loamy and saturated for most of the year.

Proven Lake soils occur in close association with Proven Lake peaty phase, Valley and Swanford soils. They are similar to Valley soils by having similar texture and parent material but are more poorly drained. Swanford soils are better drained and slightly lighter in texture. Proven Lake soils are the Meadow associate of the Proven Lake soil Association as mapped in the reconnaissance survey of soils in the Rossburn Virden area.

Rackham Series (RKH)

The Rackham series consists of moderately to well drained Orthic Gray Luvisol soil developed on deep (>100 cm), moderately to strongly calcareous, loamy to fine loamy lacustrine deposits. These soils occur in upper positions of gently sloping, hummocky landscapes and have moderate permeability, moderate surface runoff and a medium low water table during the growing season. Rackham soils are moderately eroded, non-stony and non-saline. They have moderate available water holding capacity, and low to medium organic matter content. Native vegetation often includes aspen, white birch, and spruce, with an under growth of hazel, dogwood, rose, and cranberry. The majority of these soils are currently used for annual crop production.

In a representative profile of Rackham soil the solum is approximately 45 cm thick. The profile is characterized by grayish brown fine sandy loam Ap horizon, 12 to 20 cm thick, a dark brown blocky clay loam Bt horizon, 12 to 35 cm thick, with a thin transitional BC horizon, overlying a moderately to strongly calcareous, silty clay loam to silt loam Ck horizon. The light color of the cultivated surface horizon results from the incorporation of the Ae with part of the Bt horizon. The parent material commonly contains thin non-pedogenic layers of variable texture.

Well drained Rackham soils occur in close association with Swan soils which are similar in texture but imperfectly drained. Rackham soils were previously mapped as the Rackham clay loam Association in the reconnaissance survey of soils in the Rossburn Virden area.

Roblin Series (RBN)

The Roblin series consists of poorly drained Humic Luvic Gleysol soil developed on deep moderately to strongly calcareous, fine loamy morainal till derived from shales, limestones, and grantic rock materials. These soils occur in depressions of gently undulating to hummocky landscapes and have slow permeability, slow surface runoff, and a moderately high water table during the growing season. Roblin soils are non-eroded, non-stony and non-saline. They have high available water holding capacity, and high organic matter content. Native vegetation often includes sedges, reeds, willows and meadow grasses. The majority of these soils are currently used for natural wetland habitat. Although most of these soils will be dry during the latter part of the growing season, many are cultivated for annual crop production. However, because of their depressional position, they have a continuing limitation for agriculture because of flooding from spring snow melt and heavy summer rains.

In a representative profile of Roblin soil the solum is approximately 60 cm thick. The profile is characterized by a gray to dark gray loamy Ap - Ahe horizon, 15 to 25 cm thick, overlying a dark brown, moderate medium subangular blocky, clayey Btg horizon, 25 to 40 cm thick, with many medium, prominent reddish yellow mottles, and a moderately calcareous, prominently mottled fine loamy Ckg horizon. The parent material is typically fine loamy morainal till, although the solum of a typical profile may often be more clayey due to the strong leaching and illuviation processes taking place near the soil surface.

Roblin soils occur in close association with Petlura and Sinnot soils. They are similar to both soils by having a similar parent material but differ from Petlura soils which have better drainage and are less leached, and from Sinnot soils because of complete lack of leaching and generally poorer drainage. Roblin soils often dry out by mid summer, whereas Sinnot soils may remain wet to saturated throughout the growing season. Roblin soil was included with the meadow associates of the Erickson soil Association previously mapped in the reconnaissance survey of soils in the Rossburn Virden area.

Rat River Series (RTV)

The Rat River series consists of very poorly drained Terric Mesisol soils developed on shallow (40 to 160 cm) deposits of mesic forest peat underlain by coarse to moderately coarse textured lacustrine sediments. The organic portion has a very thin (<15 cm) fibric moss peat layer, and underlain by dominantly mesic grading to humic forest peat. The mesic forest peat is very dark brown, slightly acid to neutral, fine fibered, sticky material layered with variable amounts of woody debris. This layer grades into black, highly decomposed peat which may be of fen or forest origin. The native vegetation consists of productive stands of black spruce with some tamarack and understory of Labrador Tea, and feathermosses. Sphagnum moss is of limited occurrence being found as small raised hummocks.

Rat River soils are similar to Okno soils in material and composition but differ from Okno soils by having a coarse textured mineral soil underlying. Rat River soils were previously mapped as undifferentiated peat and half bog soils in the reconnaissance survey of soils in the Rossburn Virden area.

Sand Beach Soils (SDB)

The Sand Beach soils consists of rapidly to very poorly drained Orthic to Gleyed Regosol soil developed on stratified sandy to gravelly water sorted deposits of variable thickness. Most of these soils are of recent origin and are continuously affected by wave action and fluctuating water levels. These soils occur adjacent to water bodies and lakes of sufficient size to facilitate water and wave influence on the shoreline deposits. Sand Beach soils have high permeability, slow surface runoff and a very high water table during the growing season. Sand Beach soils are often water eroded, non-to very stony and non-saline. They have low available water holding capacity, and generally very low organic matter content. Native vegetation often includes horsetail, with some sedges and scattered clumps of willow, and herbaceous plants. The majority of these soils are currently used for recreational purposes if they are of sufficient size and continuity.

A representative profile of Sand Beach soil has little to no solum. The profile is characterized by single grained sandy to gravelly materials of variable thickness, with abundant iron mottling and course fragments. The sands are often weakly to moderately calcareous due to inclusions of sand size limestone fragments. The parent material is typically mottled and stratified.

Sand Beach soils occur in close association with outwash and morainal deposits. Sand Beach soils were not mapped in the Rossburn Virden area because of their very limited extent. They were included with soils mapped in the Seech and Zaparosa soil associations.

Seech Series (SHH)

The Seech series consists of well drained Calcareous Black soil developed on deep (>100 cm) moderately calcareous, coarse sandy to gravelly deltaic, beach or outwash deposits. These soils occur on upper slope to crest positions of moderately sloping hummocky landscapes and have high permeability, slow surface runoff and a very low water table during the growing season. Seech soils are slightly eroded by wind and water, slightly to moderately stony and non-saline. They have very low available water holding capacity, and low organic matter content. Native vegetation often includes prairie grasses, herbs, and shrubs. The majority of these soils are currently used for improved pasture and annual crop production.

In a representative profile of Seech soil the solum is approximately 32 cm thick. The profile is characterized by dark gray to black, gravelly loamy fine sand Apk horizon, 10 to 35 cm thick, with inclusions of coarse fragments of shale and limestone, a yellowish brown, moderately calcareous loamy sand Bmk horizon, 10 to 40 cm thick, with abundant coarse fragments, overlying a strongly calcareous stratified gravelly Ck horizon. The parent material contains abundant coarse frgagments derived from shales, limestones, and granitic rocks. A typical profile also contains unweathered limestones throughout which accounts for the high carbonate content in a highly porous soil.

Seech soils occur in close association with Katherine and Bethany soils. They are similar to both soils by having similar parent material but differ from both soils because of better drainage. Katherine soils are more leached, due to the increased amount of moisture in concave-shaped slopes. Bethany soils on

the other hand, occur in depressions and have a high water table which restricts leaching. Seech soils were previously mapped as Seech association in the reconnaissance survey of soils in the Rossburn Virden area.

Sinnott Series (SNT)

The Sinnott series consists of poorly to very poorly drained Rego Humic Gleysol soil developed on deep (>100 cm) moderately to very strongly calcreous, loamy to fine loamy morainal till derived from shales, limestones, and granitic rock materials. These soils occur in depressional positions in undulating to hummocky landscapes and have low permeability, very slow surface runoff and a very high water table during the growing season. Sinnott soils are non-eroded, sometimes stony and non-saline. They have high available water holding capacity, and high organic matter content. Native vegetation often includes black spruce , labrador tea, and feather mosses if the surface is peaty, and when the surface is not peaty, sedges, slough grasses, willow, and alder prevail. The majority of these soils are currently used for wetland habitat. Few are drained and cultivated.

In a representative profile of Sinnott soil the solum is approximately 30 cm thick. The profile is characterized by moderately decomposed peaty (Om) horizon, 6 to 15 cm thick, overlying a granular, black moderately calcareous, loamy Ahk (Apk) horizon, 10 to 25 cm thick, a thin loamy transitional AC horizon, grades into an olive to olive gray, strongly calcareous, strongly mottled, fine loamy Ckg horizon. The parent material typically contains material that has been washed and/or blown into the depression from surrounding higher lands thus giving the upper part of the soil more of a lacustrine appearance than the underlying (Ckg) parent material with its inherent coarse fragments.

Sinnott soils occur in close association with Roblin and Petlura soils. They are similar to both soils by having similar parent material but differ from Roblin soils because of a more persistent saturation and lack of leaching, and from Petlura soils which are also leached but are imperfectly drained. Sinnott soils were included in areas previously mapped as half bog and as meadow associates of the Erickson Association in the Rossburn Virden area.

Stead Series (STD)

The Stead series consists of very poorly drained Typic Mesisol soil developed on deep (>160 cm), moderately decomposed, fen peat materials overlying calcareous, loamy to clayey lacustrine deposits. These soils occur in deep depressions and occasionally surround small bodies of open water in nearly level to undulating and hummocky morainal landscapes. Stead soils have moderately slow permeability, no surface runoff and a very high water table during the growing season. They have high available water holding capacity, high organic matter content, and are usually very deficient in phosphorous, potassium, and copper. They also have a colder micro-climate than adjacent mineral soils. Native vegetation often includes sedges, reeds and grasses with some scattered clumps of willow and swamp birch. The majority of these soils are currently used for wetland habitat.

In a representative profile of Stead soil the organic material is approximately 160 cm thick. The profile is characterized by medium to neutral, non-woody, uniform fen peat, overlying undifferentiated mineral

materials usually consisting of loam to clayey textured lacustrine deposits. A typical profile may contain some layering of peat materials due to variable stages of decomposition, more commonly however, the peat gradually becomes more decomposed and more dense with depth.

Stead soils occur in close association with Cayer soils. They have a similar type and composition of organic materials but differ from Cayer soils because of a greater thickness of peat. Stead soils were previously mapped as undifferentiated peat in the reconnaissance survey of soils in the Rossburn Virden area.

Swan Series (SWN)

The Swan series consists of imperfectly drained Gleyed Dark Gray soil developed on deep (>100 cm), moderately to strongly calcareous, loamy to fine loamy lacustrine deposits. These soils occur in middle to lower positions of very gently sloping to undulating landscapes and have moderately slow permeability, moderate surface runoff and a medium to low water table during the growing season. Swan soils are susceptible to erosion, and are non-stony and non-saline. They have medium high available water holding capacity, and high organic matter content. Native vegetation often includes aspen, balsam poplar, and birch with an understory of hazel, rose, dogwood, willow, herbaceous plants and grasses. The majority of these soils are currently used for annual crop production.

In a representative profile of Swan soil the solum is approximately 42 cm thick. The profile is characterized by dark gray, granular,loamy Ap - Ah horizon, 15 to 22 cm thick, overlying a grayish brown to olive, clayey Bt horizon, 15 to 80 cm thick, with few medium distinct mottles in the lower part, a fine loamy transitional BC horizon, 15 to 20 cm thick may occur between the Bt and Ckg horizon. The Ckg horizon is a yellowish brown clay loam with many medium distinct mottles.

Swan soils occur in close association with Onanole and Proven Lake Soils. They are similar to both soils by having the same textural range and parent material but differ from Onanole soils which are better drained, and from Proven Lake soils which are not leached and poorly drained. Swan soils were previously included as the intermediately drained associate of the Onanole Association as mapped in the reconnaissance survey of soils in the Rossburn Virden area.

Swanford Series (SWF)

The Swanford series consists of imperfectly drained Gleyed Rego Black soil developed on deep (>100 cm), moderately to very strongly calcareous, loamy to fine loamy, lacustrine deposits. These soils occur in middle and lower positions of nearly level to gentle slopes on lacustrine landscapes and have moderately slow permeability, slow surface runoff and a medium low water table during the growing season. Swanford soils are generally non-eroded, non-stony and non-saline. They have high available water holding capacity, and high organic matter content. Native vegetation often includes aspen, balsam poplar and birch with an understory of dogwood, willow, herbaceous plants and grasses. The majority of these soils are currently used for improved pasture and annual crop production.

In a representative profile of Swanford soil the solum is approximately 40 cm thick. The profile is characterized by dark gray to black, granular clayloam Ap - Ah horizon, 10

to 15 cm thick, overlying a dark gray to black, loamy Ahk horizon, 10 to 15 cm thick, a loamy transitional AC horizon, 5 to 10 cm thick with many fine faint mottles and a loamy, mottled, strongly calcareous Ckg horizon. Swanford soils occur in close association with Proven Lake and Onanole soils. They are similar in texture to both soils, but are less well drained and less leached than Onanole soils, and better drained than poorly drained Proven Lake soils. Swanford soils were previously mapped as the intermediately drained associate of the Onanole Association in the reconnaissance survey of the soils in the Rossburn Virden area.

Tee Lake Series (TEK)

The Tee Lake series consists of imperfectly drained Gleyed Gray Luvisol soil developed on deep (>100 cm), moderately to strongly calcareous, fine loamy, slightly to moderately stony morainal deposits. These soils occur on lower slope and depressional positions of undulating to hummocky landscapes and have moderate permeability, moderately rapid surface runoff and a low water table during the growing season. Tee Lake soils are non-eroded, slightly to moderately stony and non-saline. They have medium to high available water holding capacity, and medium organic matter content. Native vegetation often includes white spruce, balsam fir, dogwood and herbaceous plants. The majority of these soils are currently used for natural habitat and improved pasture.

In a representative profile of Tee Lake soil the solum is approximately 31 cm thick. The profile is characterized by a leaf mat (LFH) horizon, 3 to 6 cm thick, a light gray weak fine platy, loamy Ae - Aegj horizon, 8 to 15 cm thick, a gleyed clay loam Btgj horizon 8 to 35 cm thick a gleyed clay loam transitional BC horizon, 5 to 15 cm thick overlying a gleyed, strongly mottled, strongly calcareous, loamy Ckg horizon. The parent material is derived from glacial till consisting of shales, limestones, and granitic rocks.

Tee Lake soils occur in close association with Waitville, Roblin, and Sinnott soils. They have similar parent materials but differ from Waitville soils which are better drained, and from Sinnott soils which are not leached and are poorly drained. Tee Lake and Roblin soils are quite similar in that they are both strongly leached but Roblin soils are more poorly drained. Tee Lake soils were included in areas previously mapped as the intermediately drained associate of the Waitville Association in the Rossburn Virden area.

Valley Series (VLY)

The Valley series consists of imperfectly drained Gleyed Rego Black soil developed on uniform, deep (>100 cm), moderately to strongly calcreous, fine loamy lacustrine deposits. These soils occur on lower slope to depressional positions of nearly level lacustrine landscapes and have moderate permeability, moderately slow surface runoff and a medium water table during the growing season. Valley soils are not usually eroded, non-stony and non-saline. They have high available water holding capacity, and medium to high organic matter content. Native vegetation often includes aspen, balsam poplar, with an understory of tall shrubs, herbaceous plants and meadow grasses. The majority of these soils are currently used for annual crop production.

In a representative profile of Valley soil the solum is approximately 23 cm thick. The profile is char-

acterized by very dark gray to black, clay loam, Ap and Ah horizon, 15 to 30 cm thick, overlying a thin AC and a gray to light gray layer of lime accumulation Cca horizon 5 to 15 cm thick. The parent material is a strongly calcareous, mottled, yellowish brown, clay loam (Ckgj).

Valley soils occur in close association with Swan and Proven Lake soils. They are similar to both soils by having the same parent material but differ from Swan soils because of the presence of carbonates throughout the profile. Valley soils are carbonated like Proven Lake soils but are better drained. Valley soils were previously mapped as the intermediately drained associate of the Onanole Association in the Rossburn Virden Map area.

Vista Series (VST)

The Vista series consists of poorly drained Rego Humic Gleysol soil developed on deep, stratified, moderately calcareous, coarse textured sandy lacustrine deposits. These soils occur in depressional positions of nearly level to gently undulating landscapes and have moderately high permeability, slow surface runoff and a high water table during the growing season. Vista soils are non-eroded, non-stony and non-saline. They have low available water holding capacity, and low organic matter content. Native vegetation often includes sedges, reeds, willow and meadow grasses. The majority of these soils are currently used for natural grazing and improve pasture.

In a representative profile of Vista soil the solum is approximately 34 cm thick. The profile is characterized by dark gray, fine sandy loam Apk - Ahk horizon, 10 to 28 cm thick, overlying a thin carbonated transitional sandy textured AC horizon, 10 to 15 cm thick, and a strongly mottled, strongly calcareous, gray to olive gray, loamy sand Ckg horizon. Many of the Vista soils in this study area may have a peaty surface layer 10 to 30 cm thick.

Vista soils occur in close association with Kircro, Lenswood and Bethany soils. They are similar in texture to Lenswood soils but are more poorly drained. Bethany soils are better drained and slightly coarser in texture than Vista soils. Vista soils with peaty surface layers are similar to Kircro soils but the Kircro soils have a greater thickness of peat (>40 cm). Vista soils were previously mapped as the meadow associate of the Rackham association sandy phase, in the reconnaissance survey of soils in the Rossburn Virden area.

Wellman Series (WLM)

Wellman series consists of imperfectly drained Gleyed Dark Gray Luvisol soils developed on deep (>100 cm) moderately to strongly calcareous clayey textured morainal till deposits derived predominantly from Cretaceous shales. These soils occur in lower slopes on nearly level to gently sloping hummocky landscapes. Wellman soils have slow to very slow permeability, moderate to slow surface runoff and a moderately low water table during the growing season. Wellman soils are non eroded, very slightly stony and non-saline. They have high available water holding capacities and moderately high organic matter contents. Native vegetation typically includes grasses, shrubs and herbaceous plants. Some of these soils in this study are used for crop production.

The average solum thickness of Wellman soils in this study was 42.5 cm with an A horizon of 20.5 cm. A

typical profile contains a dark gray clayey Ap horizon, and a medium to strong subangular blocky, dark grayish brown clay textured Bt horizon 15 to 20 cm thick. The lower portion of the profile is weakly to strongly calcareous and grades through a thin BC horizon to the underlying clayey Ckgj horizon containing many prominent mottles. Coarse fragments of shale and occasional weathered limestones are common in the parent material.

Wellman soils are very similar to Meadowbrook soils in profile characteristics with the exception that drainage is poorer. In contrast to the poorly drained Breckon soils, surface ponding is only temporary on Wellman soils. Wellman soils were formerly mapped in the Meadowbrook soil association in the reconnaissance survey of soils in the Rossburn Virden Area.

Waitville Series (WTV)

The Waitville series consists of well drained Orthic Gray Luvisol soil developed on deep (>100 cm), moderately to strongly calcareous, stony, loamy to fine loamy morainal deposits. These soils occur on middle to upper positions of moderately to strongly sloping hummocky landscapes and have slow permeability, moderately rapid surface runoff and a very low water table during the growing season. Waitville soils are slightly to moderately eroded, moderately stony and non-saline. They have medium-high available water holding capacity, and low organic matter content. Native vegetation often includes aspen, white spruce, birch, with an under growth of hazel dogwood, rose, cranberry, shrubs, herbaceous plants and grasses. The majority of these soils are currently used for productive woodland and when cleared, they are used for forages on steep slopes, and annual crop production on less steeply sloping topography.

In a representative profile of Waitville soil the solum is approximately 60 cm thick. The profile is characterized by gray to light gray loamy granular Ap - Ahe horizon, 10 to 20 cm thick, overlying a thin light gray weak platey Ae horizon, 3 to 5 cm thick, a well developed, brownish, strong medium subangular blocky, fine loamy to clayey, Bt horizon, 15 to 45 cm thick grading gradually to a moderately calcareous, clay loam Ck horizon. The parent material is derived from mixed materials consisting of shale, limestone, and granitic rock. A typical profile also contains stones and coarse fragments throughout.

Waitville soils occur in close association with Erickson and Tee Lake soils. They are better drained than Tee Lake soils and more leached than Erickson soils. Waitville soils were previously mapped as the Waitville Association in the reconnaissance survey of soils in the Rossburn Virden area.

Wapus Series (WPU)

The Wapus series consists of well drained Orthic Gray Luvisol soil developed on thin (25 to 100 cm), medium textured, non to weakly calcareous, shaly, loamy till, deposits overlying weathered shale bedrock. These soils occur on the crest positions of strongly sloping, hummocky landscapes and have moderately high permeability, rapid surface runoff and a very low water table during the growing season. Wapus soils are moderately eroded, slightly stony and non-saline. They have low to medium available water holding capacity be-

cause of the high shale content, and low organic matter content. Native vegetation often includes aspen, birch, and white spruce, with an understory of hazel, rose, saskatoon, chokecherry, and grasses. The majority of these soils are currently not used and remain in native grazing.

In a representative profile of the Wapus soil the solum is approximately 50 cm thick. The profile is characterized by dark gray, sandy loam textured Ah -Ahe horizon, 5 to 8 cm thick, overlying a dark gray brown, granular, shaly clay loam Bt horizon, 20 to 50 cm thick, and a weakly calcareous, shaly loam Ck horizon which grades gradually into a weathered, very fractured shale bedrock. The shale bedrock breaks readily into dark gray flakes.

Wapus soils occur in close association with Waitville and Erickson soil in the Gertrude Lake area where remanent shale bedrock cores protude through the moderately calcareous tills. Wapus soils are less calcareous and have much higher shale content than either the Waitville or Erickson soils. Wapus soils were not previously mapped in the reconnaissance survey of the soils in the Rossburn Virden area.

Zaparosa Series (ZAP)

The Zaparosa series consists of well to rapidly drained Orthic Gray Luvisol soil developed on deep (>100 cm), stratified, extremely calcareous, coarse sandy to gravelly deltaic, beach, or outwash deposits. These soils occur on upper slope and crest positions of undulating to hummocky landscapes and have rapid permeability, slow surface runoff and a very low water table during the growing season. Zaparosa soils are moderately eroded, slightly stony and non-saline. They have very low available water holding capacity, and low organic matter content. Native vegetation often includes some aspen, and white spruce, with shrubs and prairie grasses. The majority of these soils are currently used for improved pasture, some are used as a source of road aggregate, and others are cultivated for annual crops.

In a representative profile of Zaparosa soil the solum is approximately 50 cm thick. The profile is characterized by a gray to light gray, granular, sandy loam Ap - Ae horizon, 10 to 20 cm thick, overlying a brownish, weak medium subangular blocky, sandy loam Bt horizon, 20 to 60 cm thick, grading gradually into a very strongly calcareous gravelly Ck horizon. A typical profile contains coarse fragments throughout.

Zaparosa soils occur in close association with Seech, Katherine, and Heron Creek soils. They are similar to Seech and Katherine soils by having similar texture, but Katherine soils are imperfectly drained. Heron Creek soils are poorly drained and usually have a sandy loam surface texture. Zaparosa soils were previously mapped as Zaparosa Association in the reconnaissance survey of soils in the Rossburn Virden area.

PART 4

USE AND MANAGEMENT INTERPRETATIONS OF SOILS

4.1 INTRODUCTION

This section provides an assessment of performance or soil suitability ratings for various uses of soils based on field observations of soil and landscape characteristics, laboratory data, and on observations of soil behaviour under specified conditions of land use and management. Suitability ratings or interpretations are intended only to serve as guides for planners and managers. Caution, with an understanding of the limitations of the soil map must be exercised when applying suitability ratings to soil map units. The value of any rating or interpretation depends upon the nature and composition of individual map unit delineations which in turn depends on the scale of mapping and intensity of ground truthing employed in the survey.

In this section, interpretive soil information is provided for the following land-use evaluations:

1. Agriculture
   a) dryland farming capability
   b) irrigation suitability
2. Engineering Uses
3. Recreation Uses

4.2 AGRICULTURAL LAND USE EVALUATION

Climatic Conditions for Crop Production

Regional climatic conditions in the South Riding Mountain Planning District are favourable for the growth of cereals and other adapted crops. Maximum temperatures and precipitation occur during the growing season. Mean daily temperatures and average growing season precipitation are given in Tables 2 and 3, respectively. Rainfall, when combined with average levels of stored soil moisture is adequate for crop growth in most years. However, year to year variation in growing season precipitation may be quite large[7]. Insufficient growing season precipitation may affect crop yields about 25 percent of the time and excess precipitation during the growth period or excessive rainfall at harvest may affect yields over an additional 25 percent of the time. A summary of climatic information relevant to crop production in the study area is presented in Table 8.

In the South Riding Mountain Planning District, the average date of last frost in spring is June 7 and the average date of the first fall frost is September 5. These data in-

[7] Dunlop, S. and C.F. Shaykewich. 1982. Southern Manitoba's Climate and Agriculture. Manitoba Agriculture.

dicate the average growing season is 100 days (Table 8). The risk of frost occurrences based on the frequency of past observations is also shown in Table 8. These probabilities are important for a proper evaluation of the suitability of an area for growing certain crops. These data give the chance or probability for the last spring frost to occur on or before, and the first fall frost to occur on or after a particular date. The probability of the frost-free period being equal to or less than the period indicated in days is also given.

Other climatic parameters relevant to the study area are also presented in Table 8. The length of growing season for hardy agricultural crops is based on a killing frost of -2.2 degrees C. Using this criterion, the average frost-free period is 130 days. Another climatic factor useful for evaluation of the agricultural potential of an area is growing degree-days. For plant growth, degree-days accumulated for a base temperature of 5 degrees C express the length and warmth of the growing season in a single figure. The heat unit figures serve as an index of the amount of energy available to plants for growth. The South Riding Mountain Planning District averages 1400 growing degree-days during the May 1 to September 30 period. Corn Heat Units (CHU) provide yet another evaluation of the thermal attributes of a region in relation to a specific crop. The average accumulation of corn heat units is 2150, generally not sufficient for grain corn production but suitable for silage production utilizing corn hybrids with lower heat unit requirements.

Most soils in the South Riding Mountain Planning District experience varying degrees of soil water deficit for varying periods of time. Soil water deficits calculated for this area vary greatly depending on properties and characteristics of the soil and the period in the growing season for which the calculation is made. The soil moisture deficits shown in Table 8 are calculated for loamy textured soils with an available water holding capacity of about 200 mm. Research shows that about one-half of this amount, or 100 mm is readily available to plants. Once the first 100 mm is used up, the rate of plant growth drops, the crop is considered to be in a stress situation and the soil water status takes on negative values. The values shown in Table 8 will be higher on sandy soils with a lower soil water capacity (160 mm) and lower on clayey soils with a larger soil water holding capacity. Soils with a high water table will have lower soil water deficits as long as the water table is within 1 m of the soil surface.

Table 8 Climatic Information Relevant to Crop Production in the South Riding Mountain Planning District Study Area.

Spring Frost - Date of Occurrence	Average
Last Spring Frost (0°C)	May 25
" " " (0°C) - 25% risk after	June 4
" " " (0°C) - 10% risk after	June 9
" " " (-2.2°C)	May 15
" " " (-2.2°C) - 25% risk after	May 20
" " " (-2.2°C) - 10% risk after	May 30

Fall Frost - Date of Occurrence	
First Fall Frost (0°C)	Sept 5
" " " (0°C) - 25% risk before	Aug 25
" " " (0°C) - 10% risk before	Aug 15
" " " (-2.2 C)	Sept 22
" " " (-2.2 C) - 25% risk before	Sept 15
" " " (-2.2 C) - 10% risk before	Sept 8

Frost Free Period	
Above (0°C)	100 days
(0°C) @ 25% risk	85 days
(0°C) @ 10% risk	75 days
Above (-2.2°C)	130 days
(-2.2°C) @ 25% risk	120 days
(-2.2°C) @ 10% risk	110 days

Degree Days (D.D) Above 5°C	
Accumulated No. of Growing D.D	1400
" " " " D.D @ 25% risk	1300
" " " " D.D @ 10% risk	1200

Corn Heat Units (CHU)	
Accumulated No. of CHU	2150
" " " CHU 25% risk	2000
" " " CHU 10% risk	1800

Growing Season Precipitation (m.m)	
Period May 1 to Sept 30	325
" May 1 to Sept 30, 25% risk of less than	250
" May 1 to Sept 30, 25% risk of more than	375

Soil Water Status for Forage Crops (Deficit in MM)		Average
After First Crop of Alfalfa		-25
" " " " "	@ 25% risk	-50 to -75
" " " " "	@ 10% risk	-100
After Second Crop of Alfalfa		-125
" " " " "	@ 25% risk	-200
" " " " "	@ 10% risk	-250

Soil Water Status for Cereal Crops (Dificit in MM)		
Soft Dough Stage in Wheat		-25
" " " " "	@ 25% risk	-50
" " " " "	@ 10% risk	-100

Soil Water Status Under Long Season Crops (MM)		
At silking in Corn		-25
" " " "	@25% risk	0
" " " "	@10% risk	-25

* - Dunlop, S. and C.F. Shay kewich. 1984. Southern Manitoba Climate and Agriculture, Faculty of Agriculture, University of Manitoba, Pub. Manitoba Agriculture.

** Note: A Negative value indicates amount of water that would be needed at the particular growth stage to avoid yield decreases due to water stress (i.e. negative values are water deficits). These data are based on a uniform medium textured soil.

Soil Properties and Soil Management

Soil management problems affecting agricultural land use include stoniness, drainage, excess soil moisture, erosion and soil fertility. This section discusses the soil properties related to each of these problems.

STONINESS

- The effect of stones on soil management and productivity depends upon their number and size. Occasional surface stones (classes 1 and 2) offer no serious limitations to cultivation and cropping; however, excessively stony soils (class 5) can prevent cultivation altogether.

In the South Riding Mountain Planning District various degrees of stone clearing are required on soils developed on glacial till (Erickson, Waitville and Petlura series) and to a lesser extent on soils developed on thin lacustrine veneers underlain by stony glacial tills (Banks and Ozerna series). Although stone clearing can be a largely mechanized procedure such operations still incur costs not applicable to non-stony soils.

DRAINAGE

- Soil drainage refers to the frequency and duration of periods when the soil is free of saturation or partial saturation. Soil drainage is affected by several factors acting separately or in combination including texture, structure, gradient and length of slope, water holding capacity and climatic factors controlling evaporation and evapotranspiration. Inadequate soil drainage occurs when these factors restrict or impede the movement of water from the soil resulting in conditions of excess water on or within the soil.

Under natural conditions some soils are so wet that the production of crops commonly grown in the area is generally not possible. The poorly drained gleysolic soils (Roblin, Sinnott, Breckon, Herron Creek, Vista, and Proven Lake soils) are not generally used for annual crop production, unless surface and/or subsurface drainage is provided and maintained. The majority of these soils remain in the native state supporting vegetation associated with wet lands and marsh.

A major limitation to drainage improvement in this area is the hummocky topography and the lack of a well developed natural surface drainage network. The majority of these wet soils occur in isolated depressional areas and sloughs.

Petlura, Tee Lake, Poppleton, Lenswood, Swan, Swanford, Dickson and Valley soils have adequate drainage in most years. They tend to dry out slowly in the spring and in wet years tillage and planting are delayed. In most years drainage is adequate the additional moisture resulting from the soil position in the landscape is beneficial for crops. These soils will benefit from improved drainage in some years. Well drained soils such as Waitville, Erickson, Wapus, Meadowbrook, Zaparosa, Horod, Seech, Bluewing, Davidson, Rackham, Onanole, Ozerna and Banks soils do not require drainage improvement.

Drainage classification of mineral soils indicates 75 percent well drained, 12 percent imperfectly drained and 13 percent poorly drained. Organic soils are classified as very poorly drained and occupy about 10 percent of the study area.

SOIL MOISTURE

- In Manitoba, growing season precipitation is often insufficient to meet optimum needs of the crop. Ag-

ricultural crops will show stress on most medium textured soils during years of below normal precipitation. Well drained sandy soils, on the other hand, have low water holding capacity and cause plants to undergo moisture stress at various times during the growing season when soil water is used up and the distribution of rainfall is somewhat erratic. Crops growing on Zaparosa, Horod, Seech, Blue Wing, and Davidson soils are susceptible to yield reductions resulting from lack of moisture.

Banks and Ozerna soils are slightly more drought resistant due to the occurrence of a less permeable till or lacustrine substrate. A number of management practices to maintain the soil in the best possible condition to take in and store precipitation falling on the land can be applied to these soils. Maintenance of a good supply of organic matter in the soil through continuous cropping, avoiding the use of summerfallow and maintaining a trash cover of stubble and straw all help to increase water use efficiency and to reduce loss of water by evaporation, runoff or deep percolation. Timeliness of cultivating and seeding operations affect the conservation of soil moisture and also aid in erosion control.

SOIL SALINITY

- Saline soils are soils that contain sufficient concentrations of neutral soluble salts to adversely affect plant growth. Soil salinity in the South Riding Mountain Planning District is rare (29.4 ha, <0.1% of study area). Only one map unit of Proven Lake soils contained sufficiently extensive areas of saline soils so as to rate a saline phase designation. However, during the course of the survey, several very small localized occurrences of salinity were surveyed. The level of salinity ranged from slight to moderate. The level of salinity and chemistry of salts in the soil is presented in Table 9. The dominant soluble salts in these soils is magnesium sulfate. This, along with the low levels of chloride ions would indicate that the salts are most likely derived from local till parent materials.

Two sample sites (NW 35-18-21W and NE 1-17-23W) show abnormally high bicarbonate levels (Table 9). In addition, the latter site also has extremely high electrical conductivity and chloride levels.

In general, there is no significant soil salinity problems in the study, although there is an apparent risk of salinity developing in some very localized areas.

Table 9. Chemistry of Salt Affected Soils in the South Riding Mountain Study Area

Location	% Sat.	E.C. mS/cm	Soluble Salts (m.e./l)							
			Ca^{++}	Mg^{++}	Na^{++}	Tot. Cat.	SO_4	CL^{-}	HCO_3^{-}	Tot. Ans.
SE 36-17-18W	86.8	3.7	29.0	37.0	7.0	44.0	68.0	1.2	4.0	73.2
	53.9	1.9	15.3	11.8	2.9	30.0	28.4	0.5	1.2	30.1
SE 26-17-18W	89.9	2.7	26.4	13.3	4.8	44.5	43.5	1.0	2.4	46.9
NW 37-17-18W	56.8	3.6	30.1	20.5	8.0	58.6	57.3	0.7	3.6	61.6
	56.8	2.3	17.1	11.7	4.4	33.2	33.1	0.7	1.8	35.6
NE 26-17-18W	259.5	2.7	25.8	19.1	1.5	46.4	40.1	1.7	2.6	44.4
SW 27-17-18W	78.9	4.0	25.7	44.7	2.9	73.3	67.8	3.2	2.2	73.2
NE 30-18-18W	181.5	4.2	27.8	38.1	5.4	71.3	63.7	1.0	3.6	68.3
SE 36-18-18W	75.7	9.3	20.4	119.6	22.2	162.2	198.3	2.7	6.4	207.4
	51.5	5.3	18.6	54.9	8.8	82.3	96.7	4.1	3.0	103.8
SW 30-18-20W	62.6	8.0	23.3	97.0	81.6	201.9	152.3	0.7	7.2	160.2
	62.9	2.9	19.4	20.1	6.7	46.2	45.2	0.7	1.6	47.5
SE 35-18-21W	80.6	7.4	22.2	102.3	30.2	154.7	139.6	1.0	4.8	145.4
	79.1	3.0	11.7	29.8	7.1	48.6	45.3	0.5	2.0	47.8
NW 35-18-21W	71.4	4.9	22.1	54.9	9.5	86.5	4.6	1.0	90.0	95.6
NW 36-18-21W	55.4	4.4	23.7	42.5	8.9	75.1	71.4	0.7	4.6	76.7
	73.7	4.2	21.7	48.9	9.7	80.3	74.3	1.7	2.0	78.0
NE 01-17-23W	100.5	46.3	5.0	452.3	269.4	726.7	9.9	126.0	689.5	825.4
	50.1	44.2	24.0	33.1	65.1	122.2	3.3	2.4	100.8	106.5
	37.0	39.8	26.0	30.0	58.1	114.1	2.0	2.1	88.7	102.8

Soil Erosion Analysis

Soil erosion is a significantly serious regional soil problem in this survey area. Loss of the surface layer through erosion is damaging for many reasons. One is that productivity is reduced if the surface layer is lost and part of the subsoil is incorporated into the plow layer. This is particularly so on clayey soils where conditions of poor tilth may result, or on well drained sandy soils that tend to be droughty. A second important reason is that erosion on farmland results in sediment entering drains, streams, lakes and ditches. Controlling erosion minimizes the pollution of streams and lakes by sediment and improves water quality for fish, wildlife, recreational and municipal use.

Assessing the presence and extent of soil erosion which has already occurred is a standard procedure for detailed soil surveys. The degree or class of erosion (see Glossary) has been estimated in the field for each soil in all map units, and when significant, has been indicated as a phase of the particular soil series in the denominator of the map symbol. This assessment of degree of past erosion does not distinguish between water or wind as the agent of erosion.

A more quantitative evaluation of the potential for both water and wind erosion is through the use of the Universal Soil Loss Equation (USLE, for water erosion) and the Wind Erosion Equation. Through the use of these equations planners and land managers are better able to predict the average rates (risks) of soil erosion for different or alternative combinations of cropping systems and management practices in association with a specified soil type, rainfall pattern and local topography.

These estimates of soil erosion should not be confused with the erosion phases included with some map symbols. The erosion estimates are approximations of a given soil's potential to erode under a given set of circumstances and do not refer to erosion that has actually occurred. Erosion phases of map symbols indicate where a soil surveyor has observed erosion of sufficient severity and extent in a field to be included in the map unit's description. Erosion phases are not routinely included with soils that are defined as wind modified deposits except where the erosion has caused significant soil damage.

WATER EROSION

- Because of the fine loamy texture and undulating to hummocky topography, many soils in this area developed on relatively short, steep slopes have a higher risk of water erosion than wind erosion. Wind erosion has its largest influence on coarse textured agricultural soils on relatively level landscapes.

To calculate the rate or risk of soil loss due to water erosion, numerical values appropriate to soils and climatic conditions in this study area can be used in the Universal Soil Loss Equation.

The soil loss equation is

$$A = R K L S C P$$

where

	Comments Regarding the Use of Soil Data in This Report for Computing Soil Loss
A, is the computed soil loss per unit area, expressed in the units selected for K and for the period selected for R. In practice, these are usually so selected that they compute A in tons per acre per year, but other units can be selected.	Can be computed for individual sites or fields when all other factors are known or assumed.
R, the rainfall and runoff factor, is the number of rainfall erosion index units, plus a factor for runoff from snowmelt or applied water where such runoff is significant.	An average value of 50 could be used for R in this report. Steel (1979)* determined R=46 for Brandon and R=43 for Dauphin with a very large range for each value.
K, the soil erodibility factor, is the soil loss rate per erosion index unit for a specified soil as measured on a unit plot, which is defined as a 72.6 ft. length of uniform 9 percent slope continuously in clean-tilled fallow.	Values are computed.
L, the slope-length factor, is the ratio of soil loss from the field slope length to that from a 72.6 ft. length under identical conditions.	Values are computed.
S, the slope-steepness factor, is the ratio of soil loss from the field slope gradient to that from a 9 percent slope under otherwise identical conditions.	Values are computed.
C, the cover and management factor, is the ratio of soil loss from an area with specified cover and management to that from an identical area in tilled continuous fallow.	No values have been established for Manitoba conditions. In the meantime, data for North Dakota (Table 10) are used.
P, the support practice factor, is the ratio of soil loss with a support practice like contouring, stripcropping, or terracing to that with straight-row farming up and down the slope.	To simplify, assume P=1, i.e. no conservation methods are practised to represent worst possible case.

The soil loss equation and factor evaluation charts were initially developed in terms of the English units commonly used in the United States. The factor definitions are interdependent, and direct conversion of acres, tons, inches, and feet to metric units would not produce the kind of integers that would be desirable for an expression of the equation in that system. Therefore, only the English units are used in the initial presentation of the equation and factor evaluation materials, and their counterparts in metric units are given as follows:

English	Metric
1 Foot	= 0.3048 m
1 Ton/Acre	= 2.24 Tonnes/Hectare
K	= 0.774 K
R	= 0.576 R
C and P	- not affected by units of other factors

selecting L = 22 m and S = 9 percent, leaves L and S values unchanged.

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* Steel, B.J. 1979. Application of the Universal Soil Loss Equation in Manitoba. Unpublished B.S.A. Thesis, Dept. of Soil Science, Univ. of Man.

i) Soil Erodibility Factor - K

The term "soil erodibility" is distinctly different from the term "soil erosion" which is commonly used in soil mapping. Soil mapping assesses the extent or degree to which a soil has eroded, whereas the K factor is an expression of the sensitivity or potential of the soil to erode. The rate of soil erosion, A, in the Universal Soil Loss Equation may be influenced more by land slope, rainstorm characteristics, cover, and management than by inherent properties of the soil. However, some soils erode more easily than others even when all other factors are the same. This difference, caused by properties of the soil itself, is referred to as soil erodibility.

The soil erodibility factor in the "USLE" is designated as "K". It is a quantitative value experimentally determined. For a particular soil, it is the rate of soil loss per erosion index unit for cultivated soils under continuous fallow on a 9 percent slope, 22 m long. The most important data required to determine the K factor for individual soils are: the particle size analysis, particularly the silt and very fine sand size fractions, the organic matter content, and the nature of the surface structure. This data is pertinent to the top 15 cm of soil or the plow layer (Ap horizon). In addition, the general permeability of the soil profile is also required. This information can then be used to determine the soil erodibility factor - K from a standard nomograph (Figure 6). The K factors for some soils in the South Riding Mountain Planning District study area are provided in Table 11.

ii) Topographic Factors - LS

A second important factor is topography. Both the length and the steepness of the slopes substantially affect the rate of soil erosion by water. The two effects have been evaluated separately in research and are represented in the Soil Loss Equation by L and S, respectively. In field applications, however, considering the two as a single topographic factor, LS, is more convenient.

LS is the expected ratio of soil loss per unit area from a field slope to that from a 22 m length of uniform 9 percent slope under otherwise identical conditions. This ratio for specified combinations of field slope length and uniform gradient may be obtained directly from Table 12 by making appropriate interpolations between listed values. However, most of the slopes in this study are complex, often changing from convex to concave with decreasing elevation. To compute soil loss from complex slopes, the LS values need to be adjusted. Irregular slopes can usually be divided into segments that have nearly uniform gradient, but the segments cannot be evaluated as independant slopes when runoff flows from one segment to the next. However, acceptable LS values can be obtained for irregular slopes by assuming that:

1. The changes in gradient are not sufficient to cause upslope deposition, and

2. The irregular slope can be divided into a small number of equal-length segments in such a manner that the gradient within each segment for practical purposes can be considered uniform[8].

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[8] Wischmeier, W.H. and D.D. Smith. 1978. "Predicting Rainfall Erosion Losses - A Guide to Conservation Planning". United States Dept. of Agriculture.

Table 10. Crop Management Factors (C) for Various Crop Rotations.

Rotation	Variations	C Value
Continuous SF***	No residue	1.0
SG - SF	200# of residue at seeding time	.43
SG-SG-SG-SF	200# of residue at seeding time	.31
SG-SG-SG-SF	1000# of residue at seeding time	.19
Continuous SG	Fall chisel and spring tillage	.19
Continuous SG	No fall tillage	.15
SG - 3 years Ag - Flax	Seed grass into stubble late fall	.10
SG - 8 years Ag - Flax	Seed grass into stubble late fall	.06

***Legend for Crops

SG - spring grain
SF - summerfallow
Ag - alfalfa and grass

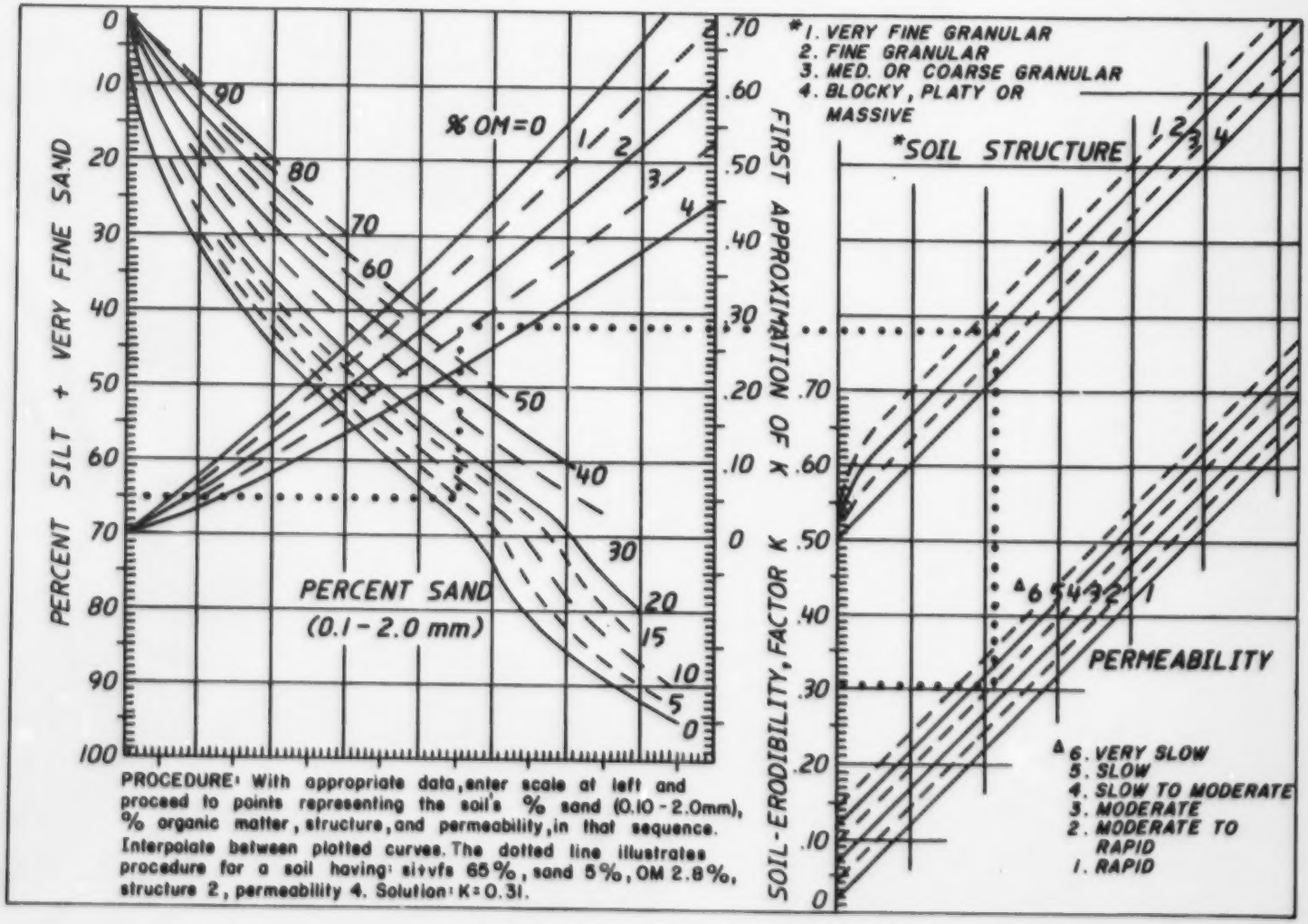

Figure 6: The soil-erodibility nomograph. Where the silt fraction does not exceed 70 percent, the equation is $100\,K = 2.1\,M^{1.14}\,(10^{-4})\,(12-a) + 3.25\,(b-2) + 2.5\,(c-3)$ where M = (percent si + vfs) (100 - percent c), a = percent organic matter, b = structure code, and c = profile permeability class. (Agric. Handbook No. 282, USDA, 1965).

Table 11. Soil Erodibility - K Factors for Some Soils in the South Riding Mountain Planning District Study Area

Soil Series	% Si + VFS [1]	% FS + MS + CS [2]	% Org. M.	Struct. Class [3]	Profile Perm. Class [4]	K Factor [5]
Banks	60	35	5.33	4	3	0.35
Bluewing	21	69	1.80	4	3	0.18
Davidson	16	72	5.70	3	1	0.13
Erickson	38	46	2.55	2	5	0.20
Heron Creek	26	51	2.20	4	1	0.14
Horod	13	75	2.12	3	1	0.06
Meadowbrook	40	0	4.70	4	5	0.18
Ozerna	21	69	1.65	4	3	0.20
Proven Lake	46	23	2.10	4	5	0.31
Seech	23	59	3.27	3	1	0.07
Swan	78	0	3.62	4	5	0.40
Swanford	45	31	5.94	3	3	0.20
Vista	25	68	8.50	4	3	0.15
Zaparosa	30	58	3.70	3	1	0.11

[1] % Si + VFS (.002-.1 mm)

[2] % Sand (.1-2 mm)

[3] Structure
Class Description
1 very fine granular
2 fine granular
3 med. or coarse granular
4 blocky, platy, or massive

[4] Profile Permeability
1 rapid
2 moderate to rapid
3 moderate
4 slow to moderate
5 slow
6 very slow

[5] From the Soil-Erodibility Nomograph

Table 12. Values of the Topographic Factor, LS, for Specific Combinations of Slope Length and Steepness[1]

Percent Slope	Slope Length (feet)											
	25	50	75	100	150	200	300	400	500	600	800	1,000
0.2	0.060	0.069	0.075	0.080	0.086	0.092	0.099	0.105	0.110	0.114	0.121	0.126
0.5	.073	.083	.090	.096	.104	.110	.119	.126	.132	.137	.145	.152
0.8	.086	.098	.107	.113	.123	.130	.141	.149	.156	.162	.171	.179
2	.131	.163	.185	.201	.227	.248	.280	.305	.326	.344	.376	.402
3	.190	.233	.264	.287	.325	.354	.400	.437	.466	.492	.536	.573
4	.230	.303	.357	.400	.471	.528	.621	.697	.762	.820	.920	1.01
5	.268	.379	.464	.536	.656	.758	.928	1.07	1.20	1.31	1.52	1.69
6	.336	.476	.583	.673	.824	.952	1.17	1.35	1.50	1.65	1.90	2.13
8	.496	.701	.859	.992	1.21	1.41	1.72	1.98	2.22	2.43	2.81	3.14
10	.685	.968	1.19	1.37	1.68	1.94	2.37	2.74	3.06	3.36	3.87	4.33
12	.903	1.28	1.56	1.80	2.21	2.55	3.13	3.61	4.04	4.42	5.11	5.71
14	1.15	1.62	1.99	2.30	2.81	3.25	3.98	4.59	5.13	5.62	6.49	7.26
16	1.42	2.01	2.46	2.84	3.48	4.01	4.92	5.68	6.35	6.95	8.03	8.98
18	1.72	2.43	2.97	3.43	4.21	3.86	5.95	6.87	7.68	8.41	9.71	10.9
20	2.04	2.88	3.53	4.08	5.00	5.77	7.07	8.16	9.12	10.0	11.5	12.9

[1] $LS = (\lambda/72.6)^m (65.41 \sin^2 \theta + 4.56 \sin \theta + 0.065)$ where λ = slope length in feet; m = 0.2 for gradients < 1 percent, 0.3 for 1 to 3 percent slopes, 0.4 for 3.5 to 4.5 percent slopes, 0.5 for 5 percent slopes and steeper; and θ = angle of slope. (For other combinations of length and gradient, interpolate between adjacent values.

Table 13. Estimated Relative Soil Losses from Successive Equal-Length Segments of a Uniform Slope[1]

Number of Segments	Sequence Number of Segment	Fraction of Soil Loss		
		m = 0.5	m = 0.4	m = 0.3
2	1	0.35	0.38	0.41
	2	.65	.62	.59
3	1	.19	.22	.24
	2	.35	.35	.35
	3	.46	.43	.41
4	1	.12	.14	.17
	2	.23	.24	.24
	3	.30	.29	.28
	4	.35	.33	.31
5	1	.09	.11	.12
	2	.16	.17	.18
	3	.21	.21	.21
	4	.25	.24	.23
	5	.28	.27	.25

[1] Derived by the formula:

$$\text{Soil loss fraction} = \frac{i^{m+1} - (i-1)^{m+1}}{N^{m+1}}$$

where i = segment sequence number; m = slope-length exponent (0.5 for slopes $\geq$ 5 percent, 0.4 for 4 percent slopes, and 0.3 for 3 percent or less); and N = number of equal-length segments into which the slope was divided.

After dividing the convex, concave, or complex slope into equal-length segments, list the segment gradients in the order in which they occur on the slope beginning at the upper end. Determine LS for each segment from Table 12. Multiply these values by the corresponding factors from Table 13 and add the products to obtain LS for the entire slope. Example: A 400 ft. convex slope on which the upper third has a gradient of 5 percent; the middle third, 10 percent; and the lower third, 15 percent:

Example:

Segment	Percent Slope	Table 8	Table 9	Product
1	5	1.07	0.19	0.203
2	10	2.74	0.35	0.959
3	15	5.12	0.46	2.355
				LS = 3.517

iii) Cropping Factor - C

The C factor measures the combined effect of all interrelated cover and management practices. Determining the appropriate C values for a region requires knowledge of the percentage of crop canopy cover of different crops, amount of residue, tillage practices and land use residuals. The C values used in North Dakota can be used for the erosion calculations in the South Riding Mountain area, since no attempt has been made to determine C values for Manitoba. Table 10 lists the values for a range of crop rotations, tillage practices and residues.

iv) Computing Soil Loss - A

Some examples of calculated soil loss values for Erickson, Seech and Rackham soils in this study area (Table 14) indicate that the topographic factor LS is the most important factor in determining soil erosion losses. Therefore, numerous field measurements for the LS factor should be made to properly assess erosion losses. Soil and water management strategies should be developed to minimize erosion according to the topographic characteristics of the fields.

The above example calculates some values for soil loss for different topographic conditions. It does not, however, indicate what is tolerable soil loss and what is excessive soil loss. In this study, calculated soil losses ranged from 2.08 T/ha on 3 percent slope to 52.8 T/ha on a 17 percent slope (Table 14).

Table 14. Data for Computing Soil Loss on Erickson, Seech and Rackham Soils with Variable Topography

Soil-Location	% VFS+Si	% FS+MS+CS	% O.M.	Struct. Class	Perm. Class	K Factor	% Slope	Slope Length M	Slope Length Ft.	LS Factor	KLS	T/AC	T/HA
Erickson Series													
NE 20-19-18W	38	46	2.8	2	5	.23	45	100	300	.621	0.142	2.21	4.95
NE 22-17-20W	40	23	1.7	2	3	.16	12(c)	70	210	2.60	0.416	3.72	14.4
NW 07-19-19W	42	19	3.4	2	3	.14	3	100	300	.400	0.06	0.93	2.08
NE 08-19-19W	36	41	2.3	2	3	.14	0.5	100	300	.119	0.02	0.31	0.69
Seech Series													
SW 03-20-22W	30	56	4.2	3	1	.15	3	200	600	.492	0.07	1.14	2.56
NW 18-19-19W	37	49	1.9	3	1	.21	17	100	300	5.25	1.10	17.09	38.28
SE 32-19-19W	18	51	4.6	3	1	.04	11	100	300	2.65	0.106	1.64	3.68
NE 23-19-19W	16	73	3.2	3	1	.05	20	80	240	6.45	0.19	4.99	11.19
NW 20-19-18W	18	72	2.3	3	1	.07	1.5	200	600	.207	0.01	0.16	0.35
SE 32-19-19W	20	57	3.4	3	1	.05	5	70	210	.790	0.04	0.62	1.37
Rackham Series													
SE 07-19-19W	59	6	2.0	2	3	.26	8	100	300	1.72	0.44	6.82	15.28
SE 31-18-19W	73	8	2.1	2	3	.38	6	15	45	.45	0.099	1.53	3.44
SE 07-19-19W	48	17	1.8	2	3	.22	12	100	300	3.13	0.69	10.70	23.96
NW 6-19-19W	61	12	2.0	2	3	.31	9	60	180	1.55	0.48	7.44	16.67
NE 36-18-20W	67	5	2.0	2	3	.34	17	100	300	4.47	1.52	23.57	52.78

R = 50
C = .31
P = 1
RCP = 15.5

Soil Loss = T/AC
A = KLS RCP
= KLS (15.5)

T/HA = T/AC x 2.24

WIND EROSION

- Wind erosion, on the other hand, is not a major concern in the South Riding Mountain study area. The irregular topography and dominantly loamy texture of the soils combine to reduce the risk of wind erosion. The soils most at risk to wind erosion are the sandy to coarse loamy textured soils on relatively level landscapes.

Wind erosion damage on susceptible soils can occur in a matter of a few hours if winds are strong and the soils are dry and bare of vegetation or surface mulch. Maintaining a plant cover, crop residue or rough surface through proper tillage minimizes the risk of erosion. In addition, erosion damage can be effectively reduced by the use of windbreaks of suitable trees and shrubs.

Research on wind erosion has been conducted in the United States for over 30 years[9]. The result of this work has been the development of eight Wind Erodibility Groups (WEG) made up of soils that have similar properties that affect their resistance to soil blowing if cultivated. Each WEG is based on soil conditions such as texture, structure and calcareousness and has been equated with an estimated annual soil loss (tonnes/ha) on a hypothetical, isolated, smooth, wide, unsheltered bare field. The soil loss tolerance factor is the maximum rate of soil erosion, whether from rainfall or soil blowing that can occur without reducing crop production or environmental quality. The rate is expressed in tonnes of soil loss per hectare per year.

The WEG concept uses soil and landscape factors based on dominant texture and level of calcium carbonate for cultivated surface soils and estimates of soil structure related to clay content. The soils in this study have been placed in the appropriate wind erodibility group in Table 15. Based on extrapolation of work in the United States and field measurements obtained in the Westbourne Soil Report area[10] only about 15 percent of the soils in this map area have the potential to exceed tolerable soil losses if not properly managed.

The estimates of erosion potential shown in Table 15, should not be confused with actual extent of past erosion in the study area. The erosion estimates indicate the potential for a specific soil to erode under a particular set of circumstances and do not refer to erosion that has actually occurred.

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[9] Woodruff, N.P., and F.H. Siddoway. 1965. A Wind Erosion Equation. Soil Sci. 29:602-608.

[10] Langman, M.N. 1984. Soils of Selected Areas in the Rural Municipality of Westbourne. Soils Report No. D51. Canada-Manitoba Soil Survey.

Table 15. Estimated Wind Erodibility Groups for Soils in the South Riding Mountain Planning District.

WEG[1]	1	2	3	4L	6	8
Relative Erodibility	Extreme	Very High	High	Moderate	Slight	None
Textural Class[2]	VFS,FS,CS,S	LS,LFS,LVFS	VFSL,FSL,SL	Loams < 35% C	Loams < 35% C	Very Wet and/or
Calcareousness	-	-	-	+	-	Organic
	DVD eroded[3] phase	DVD	BAX	MWK	WTV	RBN
			SWF	SWN	ECK	SNT
	LSW eroded[3] phase	LSW	KHI	WLM	TEK	PVK
			RKM		VLY	HEC
	ZAP	BWG	OZA		PTU	BKO
	SSH	PPL	OOL			VST
		DKS	SDB			BMY
		HRD	WPU			
						OKO
						BYN
						CAY
						STD
						KIC
						MBC
						RTV

1. WEG - Wind Erodibility Groups - indicates erosion potential or risk of soil loss from an isolated, smooth, unsheltered, wide, and bare field.
2. Textural Class: S= sand, C=coarse, F=fine, V=very, L=loam or loamy.
3. Includes overblown and moderately eroded phases.

Note: The placement of soils in WEG's does not reflect their degree of erosion. Topographic variability significantly reduces the risk of wind erosion on all soil landscapes in this study area.

The amount of actual erosion observed in the study area is summarized in Table 16. The extent of actual erosion indicated by these data differs markedly from the areal estimates of potential wind erosion. Differences between actual and potential erosion of course reflect the interaction of past soil management practices with the properties of specific soil types. Factors such as wind breaks, field size and orientation relative to prevailing wind direction and maintenance of vegetative cover and various amounts of crop residue all contribute to less severe erosion than is potentially possible.

SOIL FERTILITY

- Soil fertility is the ability of the soil to support proper plant growth. Soil fertility is naturally low in soils that are low in organic matter or in soils that are eroded. Sandy soils such as Lenswood and Poppleton have medium levels of organic matter and the sandy Davidson and gravelly Seech and Zaporosa soils have low levels of organic matter which affect the natural fertility level. Erosion reduces organic matter levels even further. Under continuous cultivation all soils may be depleted of various essential plant nutrients through removal in harvested crops. The soils in this study area have a wide range of natural fertility as can be inferred from their texture and classification. Nearly all soils used for annual crop production are typically deficient in nitrogen and phosphorous and thus, will give improved yields if these fertilizers are provided. The potassium and sulfur status of most soils is somewhat more variable. Coarse textured soils, sands to sandy loams, and organic soils are likely to be deficient in potassium. Well drained soils and Gray Luvisol soils are susceptible to sulfur deficiency. For optimum plant growth this fertility must be restored. Additions of fertilizer to soils should be based on the results of plant available soil nutrient tests, on the needs of the crop and on expected level of yields. The type and amount of nutrients needed can be assessed by the Manitoba Provincial Soil Testing Laboratory.

TABLE 16

Estimated Extent of Actual Soil Erosion

Soil Erosion Class	Areal Extent	
	Ha	% of Map Area
Slight	3,141	11.4
Moderate	2,789	10.1
Severe	430	1.5
TOTAL	6,360	23.0

4.3 SOIL CAPABILITY FOR AGRICULTURE

Dryland Agriculture

Soil capability classification for dryland agriculture is based on evaluation of both internal and external soil characteristics that influence soil suitability and limitations for arable agricultural use. In this classification, mineral soils are grouped into capability classes and subclasses based on their limitations for dryland farming, risk of damage when the soils are used and the way they respond to management[11]. There are seven capability classes, each of which groups soils together that have the same relative degree of limitation or hazard for agricultural use. The limitation becomes progressively greater from Class 1 to Class 7. The class indicates the general suitability of the soils for agriculture. The first three classes are considered capable of sustained production of common field crops, the fourth is marginal for sustained arable culture, the fifth is suitable only for improved permanent pasture, the sixth is capable of use only for native pasture while the seventh class is for soils and land types considered incapable of use for arable agriculture or permanent pasture (see definitions, Appendix F).

Organic soils within the map area are rated for "potential" agricultural capability after the method of Leeson[12]. Capability ratings of organic soils for agriculture must recognize that most organic soils have little or no value for agriculture in their native state and their potential is only achieved through reclamation or development implemented with varying degrees of difficulty. Capability class definitions for organic soils are the same as for mineral soils. They are however identified on maps and tables with the prefix "O".

Soil capability subclasses are divisions within classes which group soils with similar kinds of limitations and hazards for agricultural use. The various kinds of limitations recognized at the subclass level are defined in Table 17.

A summary of the soils in the Roblin area showing their major characteristics and their interpretive classification for dryland agriculture is presented in Table 18.

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[11] ARDA. 1965. Land capability classification for agriculture Report No. 2 Canada Land Inventory, Canada Dept. Regional Economic Expansion, Ottawa. 16 pp.

[12] Leeson, Bruce et al 1969. An organic soil capability classification for agriculture and a study of the organic soils of Simcoe County, Soil Sci. Dept., Ontario Agricultural College, Guelph, Ontario.

TABLE 17

Agricultural Capability Subclass Limitations

C- Adverse climate: This subclass denotes a significant adverse climate for crop production as compared to the "median" climate which is defined as one with sufficiently high growing-season temperatures to bring field crops to maturity, and with sufficient precipitation to permit crops to be grown each year on the same land without a serious risk of partial or total crop failures.

D- Undesirable soil structure and/or low permeability: This subclass is used for soils difficult to till, or which absorb water very slowly or in which the depth of rooting zone is restricted by conditions other than a high water table or consolidated bedrock.

E- Erosion: Subclass E includes soils where damage from erosion is a limitation to agricultural use. Damage is assessed on the loss of productivity and on the difficulties in farming land with gullies.

F- Low fertility: This subclass is made up of soils having low fertility that either is correctable with careful management in the use of fertilizers and soil amendments or is difficult to correct in a feasible way. The limitation may be due to lack of available plant nutrients, high acidity or alkalinity, low exchange capacity, high levels of carbonates or presence of toxic compounds.

I- Inundation by streams or lakes: This subclass includes soils subjected to inundation causing crop damage or restricting agricultural use.

L- Coarse wood fragments: In the rating of organic soils, woody inclusions in the form of trunks, stumps and branches (>10 cm diameter) in sufficient quantity to significantly hinder tillage, planting and harvesting operations.

M- Moisture limitation: This subclass consists of soils where crops are adversely affected by droughtiness owing to inherent soil characteristics. They are usually soils with low water-holding capacity.

N- Salinity: Designates soils which are adversely affected by the presence of soluble salts.

P- Stoniness: This subclass is made up of soils sufficiently stony to significantly hinder tillage, planting, and harvesting operations. Stony soils are usually less productive than comparable non-stony soils.

R- Consolidated bedrock: This subclass includes soils where the presence of bedrock near the surface restricts their agricultural use. Consolidated bedrock at depths greater than 1 meter from the surface is not considered as a limitation, except on irrigated lands where a greater depth of soil is desirable.

T- Topography: This subclass is made up of soils where topography is a limitation. Both the percent of slope and the pattern or frequency of slopes in different directions are important factors in increasing the cost of farming over that of smooth land, in decreasing the uniformity of growth and maturity of crops, and in increasing the hazard of water erosion.

W- Excess water: Subclass W is made up of soils where excess water other than that brought about by inundation is a limitation to their use for agriculture. Excess water may result from inadequate soil drainage, a high water table, seepage or runoff from surrounding areas.

X- Cumulative minor adverse characteristics: This subclass is made up of soils having a moderate limitation caused by the cumulative effect of two or more adverse characteristics which singly are not serious enough to affect the class rating.

Table 18. Dryland Agriculture Capability and Irrigation Suitability Classes for South Riding Mountain, D-35

Soil Symbol	Soil Name	Agric. Capability	Irrig. Suitability
BAX	Banks, loam	2X	2S
BAX/xc1x	Banks, very gently sloping, slightly stony	2T	2S
BAX/xc2x	Banks, very gently sloping, moderately stony	2TP	2S
BAX/xc3x	Banks, very gently sloping, very stony	2TP	2S
BHY	Bethany, loamy fine sand	3MW	3S
BKO	Breckon, clay	6W	4D
BWG	Bluewing, loamy fine sand	3M	3S
BWG/xcxx	Bluewing, very gently sloping	3M	3S
BWG/xexx	Bluewing, moderately sloping	4MT	4T
BWG/2exx	Bluewing, moderate erosion, moderately sloping	4MT	4T
BWG/3exx	Bluewing, severe erosion, moderately sloping	4MTE	4T
BYH	Baynham, mesic peat	05WL	4D
CAY	Cayer, mesic peat	03W	4D
DKS	Dickson, sandy loam	3MW	3Sq
DVD	Davidson, loamy sand	3M	2S
DVD/xcxx	Davidson, very gently sloping	3M	3ST
DVD/xc1x	Davidson, very gently sloping, slightly stony	3M	3ST
DVD/xdxx	Davidson, gently sloping	3M	3ST
DVD/xd1x	Davidson, gently sloping, slightly stony	3M	3ST
DVD/xexx	Davidson, moderately sloping	3MT	4TS
DVD/xfxx	Davidson, strongly sloping	4TM	4TS
DVD/1cxx	Davidson, slight erosion, very gently sloping	3M	3S
DVD/1fxx	Davidson, slight erosion, strongly sloping	4TM	4TS
DVD/1f1x	Davidson, slight erosion, strongly sloping, slightly stony	4TME	4TS
DVD/2fxx	Davidson, moderately erosion, strongly sloping	4TME	4TS
DVD/3dxx	Davidson, severe erosion, gently sloping	3ME	4TS
ECK	Erickson, clay loam	2X	3S
ECK/xcxx	Erickson, very gently sloping	2T	3S
ECK/xc1x	Erickson, very gently sloping, slightly stony	2T	3S
ECK/xc2x	Erickson, very gently sloping, moderately stony	2T	3S
ECK/xc3x	Erickson, very gently sloping, very stony	2PT	3S
ECK/xdxx	Erickson, gently sloping	3T	3ST
ECK/xd1x	Erickson, gently sloping, slightly stony	3T	3ST
ECK/xd2x	Erickson, gently sloping, moderately stony	3T	3ST
ECK/xd3x	Erickson, gently sloping, very stony	3TP	3ST
ECK/xexx	Erickson, moderately sloping	4T	4TS
ECK/xe3x	Erickson, moderately sloping, very stony	4TP	4TS

ECK/xf1x	Erickson, strongly sloping, slightly stony	5T	4TS
ECK/xf2x	Erickson, strongly sloping, moderately stony	5T	4TS
ECK/1cxx	Erickson, slight erosion, very gently sloping	2T	3S
ECK/1c2x	Erickson, slight erosion, very gently sloping, moderately stony	2TP	3S
ECK/1dxx	Erickson, slight erosion, gently sloping	3T	3ST
ECK/1d1x	Erickson, slight erosion, gently sloping, slightly stony	3T	3ST
ECK/1d2x	Erickson, slight erosion, gently sloping, moderately stony	3T	3ST
ECK/1exx	Erickson, slight erosion, moderately sloping	4T	4TS
ECK/1e1x	Erickson, slight erosion, moderately sloping, slightly stony	4T	4TS
ECK/1e3x	Erickson, slight erosion, moderately sloping, very stony	4TP	4TS
ECK/2dxx	Erickson, moderate erosion, gently sloping	3TE	3ST
ECK/2d1x	Erickson, moderate erosion, gently sloping, slightly stony	3TE	3ST
ECK/2d2x	Erickson, moderate erosion, gently sloping, moderately stony	3TE	3ST
ECK/2e1x	Erickson, moderate erosion, moderately sloping, slightly stony	4TE	4TS
ECK/2e3x	Erickson, moderate erosion, moderately sloping, very stony	4TPE	4TS
ECK/2fxx	Erickson, moderate erosion, strongly sloping	5TE	4TS
ECK/2f1x	Erickson, moderate erosion, strongly sloping, slightly stony	5TE	4TS
ECK/3d2x	Erickson, severe erosion, gently sloping, moderately stony	4TE	4TS
ECK/3d4x	Erickson, severe erosion, gently sloping, exceedingly stony	5TPE	4TS
ECK/3e2x	Erickson, severe erosion, moderately sloping, moderately stony	4TE	4TS
ECK/3f1x	Erickson, severe erosion, strongly sloping, slightly stony	5TE	4TS
HEC	Heron Creek, sandy loam	6W	4D
HECp	Heron Creek, peaty phase	6W	4D
HRD	Horod, sandy loam	3MW	3S
KHI	Katherine, loamy fine sand	3M	3S
KHI/xcxx	Katherine, very gently sloping	3M	3S
KHI/xc3x	Katherine, very gently sloping, very stony	3M	3S
KIC	Kircro, mesic peat	03W	4D
LSW	Lenswood, fine sandy loam	2M	3SD
LSW/xcxx	Lenswood, very gently sloping	2M	3SD
MWK	Meadowbrook, clay	2X	3S
MWK/xcxx	Meadowbrook, very gently sloping	2T	3S
OKO	Okno, mesic peat	04WL	1D

OOL	Onanole, loam	2X	1
OOL/xcxx	Onanole, very gently sloping	2T	2T
OOL/xdxx	Onanole, gently sloping	3T	3T
OOL/1dxx	Onanole, slight erosion, gently sloping	3T	3T
OOL/2dxx	Onanole, moderate erosion, gently sloping	3TE	3T
OOL/2exx	Onanole, moderate erosion, moderately sloping	4TE	4T
OZA	Ozerna, sandy loam	2M	2Sq
OZA/xcxx	Ozerna, very gently sloping	2M	2Sq
OZA/xc2x	Ozerna, very gently sloping, moderately stony	2M	2Sq
OZA/xdxx	Ozerna, gently sloping	3MT	3ST
OZA/xexx	Ozerna, moderately sloping	4TM	4ST
PPL	Poppleton, fine sandy loam	3M	3SvD
PPL/xcxx	Poppleton, very gently sloping	3M	3SvD
PPL/xfxx	Poppleton, strongly sloping	5MT	4TS
PTU	Petlura, loam	2W	3S
PTU/xcxx	Petlura, very gently sloping	2T	3S
PTU/xc1x	Petlura, very gently sloping, slightly stony	2T	3S
PVK	Proven Lake, clay loam	6W	4D
PVKp	Proven Lake, peaty phase	6W	4D
PVK/xxxs	Proven Lake, saline	6WN	4D
RBN	Roblin, loam	5W	4DS
RKH	Rackham, fine sandy loam	2C	3S
RKH/xdxx	Rackham, gently sloping	3T	3ST
RKH/2exx	Rackham, moderate erosion, moderately sloping	4TE	4T
RTV	Rat River, mesic peat	04WL	4D
SHH	Seech, loamy fine sand	5M	4S
SHH/xx2x	Seech, moderately stony	5MP	4S
SHH/xcxx	Seech, very gently sloping	5M	4S
SHH/xc1x	Seech, very gently sloping, slightly stony	5M	4S
SHH/xc3x	Seech, very gently sloping, very stony	5MP	4S
SHH/xdxx	Seech, gently sloping	5MT	4ST
SHH/xd3x	Seech, gently sloping, very stony	5MP	4ST
SHH/xexx	Seech, moderately sloping	5MT	4ST
SHH/xfxx	Seech, strongly sloping	5MT	4ST
SHH/1e1x	Seech, slight erosion, moderately sloping, slightly stony	5MT	4ST
SHH/1e2x	Seech, slight erosion, moderately sloping, moderately stony	5MT	4ST
SHH/1e3x	Seech, slight erosion, moderately sloping, very stony	5MT	4ST
SHH/1fxx	Seech, slight erosion, strongly sloping	5MT	4ST
SHH/2e2x	Seech, moderate erosion, moderately sloping, moderately stony	5MTE	4ST
SHH(c)	Seech (classification variant)	5M	4ST

SNT	Sinnott, clay loam	6W	1D
SNT/xx2x	Sinnott, moderately stony	6W	1D
SNTp	Sinnott peaty phase, mesic peat	6W	1D
STD	Stead, mesic peat	04W	1D
SWF	Swanford, fine sandy loam	2W	2D
SWN	Swan, loam	2W	2D
SWN/xcxx	Swan, very gently sloping	2W	2T
TEK	Tee Lake, clay loam	3W	3S
TEK/xc3x	Tee Lake, very gently sloping, very stony	3TP	3S
TEK/xx2x	Tee Lake, moderately stony	2W	3S
VLY	Valley, loam	2W	2ShD
VLY/xcxx	Valley, very gently sloping	2W	2SD
VST	Vista, fine sandy loam	6W	4D
VSTp	Vista, peaty phase	6W	4D
WLM	Wellman, clay	2W	4S
WPU	Wapus, clay	3D	1S
WTV	Waitville, sandy clay loam	3X	3S
WTV/xx3x	Waitville, very stony	1P	3S
WTV/xcxx	Waitville, very gently sloping	3X	3S
WTV/xc1x	Waitville, very gently sloping, slightly stony	3X	3S
WTV/xc2x	Waitville, very gently sloping, moderately stony	3TP	3S
WTV/xc3x	Waitville, very gently sloping, very stony	3TP	3S
WTV/xdxx	Waitville, gently sloping	3T	3ST
WTV/xd1x	Waitville, gently sloping, slightly stony	3T	3ST
WTV/xd2x	Waitville, gently sloping, moderately stony	3TP	3ST
WTV/xexx	Waitville, moderately sloping	4T	4TS
WTV/xe1x	Waitville, moderately sloping, slightly stony	4T	4TS
WTV/xe2x	Waitville, moderately sloping, moderately stony	4T	4TS
WTV/xe3x	Waitville, moderately sloping, very stony	4TP	4TS
WTV/xfxx	Waitville, strongly sloping	5T	4TS
WTV/xf1x	Waitville, strongly sloping, slightly stony	5T	4TS
WTV/xf3x	Waitville, strongly sloping, very stony	5TP	4TS
WTV/xg2x	Waitville, very strongly sloping, moderately stony	5TP	4T
WTV/1d2x	Waitville, slight erosion, gently sloping, moderately stony	4T	4TS
WTV/1exx	Waitville, slight erosion, moderately sloping	4T	4TS
WTV/1e2x	Waitville, slight erosion, moderately sloping, moderately stony	4TP	4TS
WTV/1f1x	Waitville, slight erosion, strongly sloping, slightly stony	5T	4TS
WTV/2c1x	Waitville, moderate erosion, very gently sloping, slightly stony	3TE	3S
WTV/2d2x	Waitville, moderate erosion, gently sloping, moderately stony	4TPE	4TS

WTV/2e1x	Waitville, moderate erosion, moderately sloping, slightly stony	4TPE	4TS
WTV/2e2x	Waitville, moderate erosion, moderately sloping, moderately stony	4TPE	4TS
WTV/2e3x	Waitville, moderate erosion, moderately sloping, very stony	4TPE	4TS
WTV/2f1x	Waitville, moderate erosion, strongly sloping, slightly stony	5TE	4TS
WTV/2f2x	Waitville, moderate erosion, strongly sloping, moderately stony	5TPE	4TS
ZAP	Zaparoza, loamy fine sand	5M	4S
ZAP/xd1x	Zaparoza, gently sloping, slightly stony	5M	4S
ZAP/xd2x	Zaparoza, gently sloping, moderately stony	5M	4S
ZAP/xexx	Zaparoza, moderately sloping	5MT	4ST
ZAP/xe1x	Zaparoza, moderately sloping, slightly stony	5MT	4ST
ZAP/xe2x	Zaparoza, moderately sloping, moderately stony	5MT	4ST
ZAP/xe3x	Zaparoza, moderately sloping, very stony	5MTP	4ST
ZAP/xf2x	Zaparoza, strongly sloping, moderately stony	5MTP	4ST
ZAP/1dxx	Zaparoza, slight erosion, gently sloping	5M	4S
ZAP/1d2x	Zaparoza, slight erosion, gently sloping, moderately stony	5M	4S
ZAP/2d2x	Zaparoza, moderate erosion, gently sloping, moderately stony	5ME	4S
ZAP/2exx	Zaparoza, moderate erosion, moderately sloping	5MTE	4ST
ZAP/3e1x	Zaparoza, severe erosion, moderately sloping, slightly stony	5MTE	4ST
ZAP/3e2x	Zaparoza, severe erosion, moderately sloping, moderately stony	5MTE	4ST
ZAP/3f1x	Zaparoza, severe erosion, strongly sloping, slightly stony	6TME	4ST

Irrigation Suitability

The irrigation suitability of soils is determined by evaluating the nature of both the internal and external soil characteristics.

Internal

Characteristics may be viewed as permanent and non-permanent properties; the permanent properties are those that will change little over time, while the non-permanent could be altered with time by specific management. These properties are as follows:

1. Internal Characteristics
   a) permanent - texture, uniformity and depth of geologic deposit, hydraulic conductivity and water storage capacity

   b) non-permanent - structure, drainage, fertility, reaction, salinity, exchangeable sodium

2. External Characteristics - topography, erosion, stoniness, vegetative cover

The soils of the South Riding Mountain study area have been rated for irrigation suitability (Table 18) using established guidelines summarized in Appendix F. The four classes in the irrigation suitability rating are defined as follows:

Class 1

These are soils of fine sandy loam to clay loam texture which have no significant limitations in use for irrigation. Soils have good water retention capacity, good permeability, low salt content, good drainage and satisfactory gradient of land.

Class 2

These are soils of loamy fine sand to clay loam which have slight limitations for use under irrigation. This class includes soil limitations (S) such as water holding capacity, permeability, depth of material, and salt content; topographic limitations (T) such as slope and pattern; or drainage limitations (D) such as surface drainage and depth to water table.

Class 3

These are coarse to permeable, fine textured soils having some unfavorable characteristics that limit production and cause management problems under irrigation. These include soil (S), topographic (T) and drainage (D) factors that are more restrictive than in Class 2. The soils in this class have fair to marginal suitability for irrigation.

Class 4

Soils in this class are considered poor to unsuitable for irrigation because of severe drainage problems, impermeable geological material, salinity, very low water retention capacity, very rapid permeability, topography or a combination of these problems.

4.4 SOIL SUITABILITY FOR SELECTED ENGINEERING USES

This section provides information which can be used by engineers and land use planners concerned with engineering and related geotechnical aspects of soil. It is intended to supplement the information on the soil map with additional data on engineering properties of soils.

The criteria used to evaluate soil suitability for selected engineering and related recreational uses are adopted from guides found in Coen et al[13], and from guidelines developed by the Soil Conservation Service, United States Department of Agriculture[14] and the Canada Soil Survey Committee[15].

Definition of Soil Suitability Classes

Evaluation of soil suitability for engineering and recreation uses is based on both internal and external soil characteristics. Four soil suitability classes are used to evaluate both mineral and organic soils and hence, mapping units for selected uses. These ratings express relative degrees of suitability or limitation for potential uses of natural or essentially undisturbed soils. The long-term effects of the potential use on the behaviour of the soil are considered in the rating.

The four suitability class ratings are defined as follows:

Good- Soils in their present state have few or minor limitations that would affect the proposed use. The limitations would easily be overcome with minimal cost.

Fair- Soils in their present state have one or more moderate limitations that would affect the proposed use. These moderate limitations would be overcome with special construction, design, planning or maintenance.

Poor- Soils in their present state have one or more severe limitations that would severely affect the proposed use. To overcome these severe limitations would require the removal of the limitation or difficult and costly alteration of the soil or of special design or intensive maintenance.

Very poor- Soils have one or more features so unfavourable for the proposed use that the limitation is very difficult and expensive to overcome or the soil would require such extreme alteration that the proposed use is economically impractical.

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[13] Coen et al, 1977. Soil Survey of Yoho National Park, Canada. Alberta Soil Survey Report No. 37. 208pp. Alberta Institute of Pedology, University of Alberta, Edmonton, Alberta.

[14] USDA, 1971. Guide for Interpreting Engineering Uses of Soils. Soil Conservation Service USDA. SCS-45. 87pp.

[15] CSSC, 1973. Proceedings of the Ninth Meeting of the Canada Soil Survey Committee, University of Saskatchewan, Saskatoon. 357pp.

Soil Suitability Subclasses

The basic soil properties that singly or in combination with others commonly affect soil suitability for selected engineering properties and recreation uses are provided in Table 19. These subclass designations serve to identify the kind of limitation or hazard for a particular use. Some of these soil and landscape properties for soils mapped in this study are given in Table 20.

TABLE 19

Codes utilized to identify limitations in evaluating soil suitability for selected uses

a subgrade properties

b thickness of topsoil

c coarse fragments on surface

d depth to bedrock

e erosion or erodibility

f susceptibility to frost hazard

g contamination hazard of groundwater

h depth to seasonal water table

i flooding or inundation

j thickness of slowly permeable material

k permeability or hydraulic conductivity

l shrink-swell properties

m moisture limitations or deficit

n salinity or sulphate hazard

o organic matter

p stoniness

q depth to sand or gravel

r rockiness

s surface texture

t topographic slope class

u moist consistence

w wetness or soil drainage class

z permafrost

Table 20. Soil and Landscape Properties Used to Identify Limitations for Evaluating Soil Suitability for Selected Uses (see Tables

		Symbol Codes	Soil Series											
			Banks BAZ	Bethany BHY	Brockon BRO	Bluewing BWG	Baynham BYH	Cayer CAV	Dickson DKS	Davidson DVD	Erickson ECK	Heron Creek HEC	Horod HRD	Katherine KHI	Kircro KIC
Subgrade properties (Unified Soil Classification)		a	CL	SP	ML	SM-SC	Pt	Pt	SM	SM-SC	CL	SP	SP	SP	Pt
Thickness of topsoil (volum - cm)		b	15-40	15-35	10-75	25-130	40-160	40-160	36-86	25-250	8-90	>25	>25	25-75	10
Coarse fragments on surface (% by vol.)		c	<3	<3	<3	<3	NA	NA	<3	<3	3-5	3-5	<3	<3	NA
Depth to bedrock (m)		d	>5	>5	>5	>5	>5	>5	>5	>5	>5	>5	>5	>5	>50
Erosion (class)		e	1	1	NA	1-2	NA	NA	1	1,2	1,2	NA	1	1-2	1
Susceptibility to frost hazard	*	f	L	L	M	L	H	H	L-M	L	L	L	L	L	M
Contamination hazard of groundwater	*	g	L	H	L	L	H	H	L	M	L	H	H	H	M
Depth to seasonal water table (m)		h	>2	>2	0.5-1	>2	0-0.5	0-0.5	1-2	2	2	0.5-1	>2	>2	0-.5
Flooding or inundation (frequency)	*	i	R	R	F	N	F	F	R	R	N	F	R	R	F
Thickness of slowly permeable material (cm)		j	<25	NA	>100	NA	NA	NA	N	N	25-50	N	N	N	NA
Est. permeability or hydraulic conductivity (cm/hr)		k	1.5-5	>15	0.5-1.5	>15	0.15-0.5	0.15-0.5	1.5-5.0	>15	1.5-5.0	1.5-5.0	>15	1.5-5.0	0.5-1.5
Shrink-swell properties	*	l	L-M	L	M-H	L	NA	NA	L-M	L	M	L	L	L	NA
Moisture Limitations or deficit (W.H.C.-cm/120 cm)		m	>7.5	7.5-15	>15	7.5-15	>15	>15	7.5-15	7.5-15	>15	>7.5	7.5-15	7.5-15	>7.5
Salinity or sulfate hazard (mS/cm) (topsoil)		n	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Organic matter (%)		o	2-6	>4	>4	<4	>40	>40	<4	<4	>4	>4	<4	<4	>40
Stoniness (class)		p	1	1	0	0	NA	NA	0	0	1,2,3	1	0	0	NA
Depth to sand or gravel (cm)		q	NA	<25	NA	<25	NA	NA	<25	<25	NA	<25	<25	<25	40-160
Rockiness (class)		r	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Surface texture		s	L	LFS	C	LFS	Mesic	Mesic	SL	LFS	L	LFS	SL	LFS	Mesic
Topographic slope class (see pg. 19)		t	c,d	c	e	c,d,e	e	e	c	d,e	c,d,e	e	e	c,d	e
Moist Consistence		u	Friable	Loose	Firm	Loose	NA	NA	Loose	Loose	Friable	Loose	Loose	Loose	NA
Wetness or drainage class	**	w	W	I	P	W	VP	P-VP	I	W	W	P	I	I	VP
Permafrost		z	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

* L=Low; M=Moderate; H=High; R=Rare; NA=Not Applicable; N=Nil; F=Frequent; Oc=Occasional

** W=Well; I=Imperfect; P=Poor; VP=Very Poor

Table 20 cont.

	Symbol Codes	Soil Series										
		Lenswood LSW	Meadowbrook MBK	Okno OKO	Omanole OOL	Osarna OSA	Poppleton PPL	Petlura PTU	Proven Lake PVK & PVKp	Roblin RBN	Rackham RKH	Rat River RTV
Subgrade properties (Unified Soil Classification)	a	SM-SC	ML	Pt	CL	SM	SM-SC	CL	CL	CL	CL	Pt
Thickness of topsoil (solum - cm)	b	40	8-70	40-160	17-150	28	30-90	24-110	10-50	50-80	30-55	40-160
Coarse fragments on surface (% by vol.)	c	<3	<3	NA	<3	<3	<3	<3	<3	<3	<3	NA
Depth to bedrock (m)	d	>5	>5	>5	>5	>5	>5	>5	>5	>5	>5	>5
Erosion (class)	e	1	1	NA	1	1,2	1,2	N	N	N	2	N
Susceptibility to frost hazard *	f	L	L	N	L	L-M	L-M	L	L-M	M	L	N
Contamination hazard of groundwater *	g	M	L	N	L	L	L	L	M	M	L	N
Depth to seasonal water table (m)	h	1-2	>2	.5-1	>2	>2	1-2	1-2	0-.5	1	1-2	0-.5
Flooding or inundation (frequency) *	i	F	R	F	R	R	R	OC	F	F	N	F
Thickness of slowly permeable material (cm)	j	NA	>100	25	NA	NA	NA	25-50	25-50	25-50	NA	NA
Est. permeability or hydraulic conductivity (cm/hr)	k	1.5-5.0	.15-.5	1.5-5	1.5-5	1.5-5	1.5-5	.5-1.5	1.5-5	0.5-1.5	1.5-5	5-15
Shrink-swell properties *	l	L	H	H	L-M	L	L	M	M	H	L-M	H
Moisture Limitations or deficit (W.H.C.-cm/120 cm)	m	7.5-15	>15	>7.5	>7.5	7.5-15	7.5-15	>15	>15	>15	7.5-15	>7.5
Salinity or sulfate hazard (mS/cm) (topsoil)	n	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Organic matter (%)	o	>4	>4	>40	>4	>4	<4	>4	>4	>4	<4	>40
Stoniness (class)	p	0	1	NA	1	1	0	1	NA	0	0	NA
Depth to sand or gravel (cm)	q	NA	NA	NA	NA	<25	<25	NA	NA	NA	NA	40-160
Rockiness (class)	r	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Surface texture	s	FSL	C	Mesic	L	FSL	FSL	L	Peat, CL	L	FSL	Mesic
Topographic slope class (see pg. 19)	t	b,c	c,d,e	z	c	d,e	z,c,d	z,c	z	z	c,d,e	z
Moist Consistence	u	Loose	Firm	NA	Friable	Loose	Loose	Friable	Firm	Friable	Loose	NA
Wetness or drainage class **	w	I	W	VP	W	W	I	I	VP-P	P	W	VP
Permafrost	z	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

* L=Low; M=Moderate; H=High; R=Rare; NA=Not Applicable; N=Nil; F=Frequent; Oc=Occasional

** W=Well; I=Imperfect; P=Poor; VP=Very Poor

Table 20 cont.

	Symbol Codes	Soil Series											
		Seech SHH & SHH(c)	Sinnott SNT & SNTp	Stead STD	Swanford SWF	Swan SWN	Tee Lake TEK	Valley VLY	Vista VST & VSTp	Wellman WLM	Wapus WPU	Waitville WTV	Zaparosa ZAP
Subgrade properties (Unified Soil Classification)	a	SM-SP	CL	Pt	CH	CH	CL	CL	SM-SC	MH	CL	CL	SM-SP
Thickness of topsoil (solum - cm)	b	10-50	22(<40)	>160	40	75	31	15-30	10-100	10-50	15-40	30-55	20-60
Coarse fragments on surface (% by vol.)	c	<3	<3	NA	<3	<3	<3	<3	<3	<3	<3	<3	>5
Depth to bedrock (m)	d	>5	>5	>5	>5	>5	>5	>5	>5	>5	<1	>5	>5
Erosion (class)	e	1,2	N	NA	N	1	N	N	N	1	1,2	1,2	2
Susceptibility to frost hazard *	f	L	H	H	L	L	L	L	M	L	L	L	L
Contamination hazard of groundwater *	g	H	H	H	M	L	L	L	H	L	L	L	H
Depth to seasonal water table (m)	h	2	0.5-1	0-0.5	1-2	1-2	1-2	1-2	.5-1	1-2	>2	>2	>2
Flooding or inundation (frequency) *	i	N	F	F	R	R	Oc	R	F	R	N	N	N
Thickness of slowly permeable material (cm)	j	NA	25-50	NA	NA	NA	50-100	25-50	NA	>100	>50	50	NA
Est. permeability or hydraulic conductivity (cm/hr)	k	>15	0.15-0.5	1.5-5.0	1.5-5	0.15-0.5	.5-1.5	1.5-5.0	1.5-5	0.15-0.5	.5-1.5	0.5-1.5	>15
Shrink-swell properties *	l	L	M	H	M	M	M-H	M-H	L	H	H	M	L-M
Moisture Limitations or deficit (W.H.C.=cm/120 cm)	m	<7.5	>15	>15	>7.5	>7.5	>7.5	>7.5	7.5-15	>15	>15	>15	<7.5
Salinity or sulfate hazard (mS/cm) (topsoil)	n	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Organic matter (%)	o	>4	>4	>40	>4	>4	>4	>4	>4	>4	<4	>4	<4
Stoniness (class)	p	1,2	0,1	NA	NA	NA	1,2	NA	NA	NA	1,2	1,2	1,2
Depth to sand or gravel (cm)	q	<25	NA	NA	NA	NA	NA	NA	<25	NA	NA	NA	<25
Rockiness (class)	r	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Surface texture	s	LS	L,peat	Mesic	FSL	L	CL	L	FSL,peat	C	C	L	LFS
Topographic slope class (see pg. 19)	t	c,d,e,f	x	x	x	x,c	x	x	x	x,c	c,d,e,f	c,d,e,f	c,d,e,f
Moist Consistence	u	Loose	Firm	NA	Loose	Friable	Firm	Friable	Loose	Firm	Friable	Friable	Loose
Wetness or drainage class **	w	W	P-VP	VP	I	I	I	I	P-VP	I	W	W	W
Permafrost	z	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

* L=Low; M=Moderate; H=High; R=Rare; NA=Not Applicable; N=Nil; F=Frequent; Oc=Occasional

** W=Well; I=Imperfect; P=Poor; VP=Very Poor

Guides for Assessing Soil Suitability

Guides for assessing soil suitability for ten engineering related uses are given in Appendix E (Tables 26 through 35). These tables provide as specifically as possible, definitions of the soil properties which result in the specific suitability or degree of limitation. In assessing soil suitability for various engineering uses, the degree of suitability is determined by the most restrictive or severe rating assigned to any one of the listed soil properties. For example, if the suitability is "Good" for all but one soil property and it is estimated to be "Very poor", then the overall rating of the soil for that selected use is "Very poor". Suitability of individual soil properties, if estimated to be "Fair" or "Poor", can be accumulative in their effect for a particular use. Judgement is required to determine whether the severity of the combined effects of several soil properties on suitability for a particular use will result in downgrading an evaluation. This is left to the discretion of the interpreter. It is incorrect to assume that each of the major soil properties influencing a particular use has an equal effect. Class limits established for rating the suitability of individual soil properties take this into account. For a selected use, therefore, only those soil properties which most severely limit that use are specified.

Engineering test data for several key soils in the study area are provided in Table 21.

Engineering description of the soils and their estimated properties significant to engineering are provided in Table 22. These data, in addition to information contained in the previous tables and other sections of the report have been used to rate the soils according to their suitability for ten selected engineering uses in Table 23. When using these interpretations consideration must be given to the following assumptions:

1. Interpretations are based on predictions of soil behavior under defined conditions of use and management as specified in the preamble to each of Tables 26 through 39 (Appendix E). When conditions of use and management are not the same as those defined here, new guides should be established and appropriate revisions made in Table 23.

2. Soil ratings do not include site factors such as nearness to towns and highways, water supply, aesthetic values, etc.

3. Soil ratings are based on natural, undisturbed soil.

4. Soil suitability ratings are usually given for the entire soil, but for some uses, they may be based on the limitations of an individual soil horizon or other earthy layer, because of its overriding importance. Ratings rarely apply to soil depths greater than 1 to 2 meters, but in some kinds of soils, reasonable estimates can be given for soil material at greater depths. It should be noted here that the term "soil" has been used throughout the report in the pedologic sense and differs in concept from that commonly used by engineers.

5. Poor and very poor soil ratings do not imply that a site cannot be changed to remove, correct or modify the soil limitations. The use of soils rated as poor depends on the nature of the limitations, whether or not the soil limitation can be altered suc-

cessfullly and economically, and on the scarcity of good sites.

6. Interpretations of map units do not eliminate the need for on-site evaluation by qualified professionals. Due to the variable nature of soils, and the scale of mapping, small, unmappable inclusions of soils with different properties may be present in an area where a development is planned. The need for or importance of on-site studies depends on the use to be made of the soil and the kinds of soil and soil problems involved.

Table 21. Engineering Test Data for Several Key Soils in the South Riding Mountain Planning District Study Area.

Soil Name and Location	Horizon	Depth cm	% Passing Sieve (2mm) No.10	(0.42mm) No.40	(0.074mm) No.200	% Smaller Than 0.5mm	.002mm	Liquid Limit	Plasticity Index	Shrinkage Limit %	Ratio	Lineal %	Sat. %	Textural Classification USDA	AASHO	Unified
Banks (NE 8-19-19W)	AC	25-40	99	93	61	56	25	34	16	15.2	1.9	18.3	45.3	L	A-6(8)	CL
	Ck	60-85	90	78	51	43	16	24	9	16.1	1.9	12.5	31.7	FSL	A-4(1)	SC
	IICk	85-110	90	77	56	49	19	29	14	16.2	1.9	17.0	36.7	L	A-6(4)	CL
Blue Wing (SW 4-20-19W)	Bt	29-57	100	85	31	24	15	26	9	17.0	1.8	10.0	34.0	FSL	A-2-4(0)	SC
Cayer (SW 22-19-18W)	Cg	80-100	100	86	54	47	24	34	18	13.0	2.0	16.0	48.0	SCL	A-6(6)	CL
Davidson (SW 29-18-18W)	Bt	31-42	100	70	20	18	14	25	6	17.0	1.8	7.0	32.0	SL	A-2-4(0)	SM-SC
Dickson (NE 20-19-19W)	Bmgj	12-30	100	75	24	20	12	21	3	18.4	1.8	7.0	31.9	FSL	A-2-4(0)	SM
	IICkg	98+	100	65	60	55	19	29	14	14.8	1.9	15.8	49.7	L	A-6(5)	CL
Dickson (NE 17-19-19W)	Btgj	38-66	100	85	27	24	16	24	8	17.1	1.8	10.3	38.9	FSL	A-2-4(0)	SC
	IICkgj	76-90	100	90	66	56	22	32	15	17.2	1.8	15.7	53.6	L	A-6(4)	CL
Erickson (NE 20-19-18W)	Bt	19-32	200	90	68	64	39	45	26	10.0	2.1	23.0	68.0	CL	A-7-6(15)	CL
	Ck2	75-100	100	89	70	66	22	31	14	15.0	2.0	16.0	50.0	C	A-6(6)	CL
Erickson (NE 8-19-19W)	Bt	10-25	100	84	61	58	36	42	22	13.2	2.0	22.6	70.5	CL	A-7-6(11)	CL
	Ck2	70-100	100	88	72	67	28	36	19	16.7	1.9	19.3	64.9	CL	A-6(11)	CL
Heron Creek peaty (SE 1-20-20W)	Btg	13-18	100	74	35	33	18	30	15	15.0	1.9	13.0	43.0	SL	A-2-6(1)	SC
	IICkg	81-100	100	88	64	60	17	26	12	13.0	2.0	14.0	41.0	L	A-6(5)	CL
Heron Creek (SC 18-18-17W)	AC	5-15	100	71	38	35	17	31	11	18.7	1.7	13.6	51.0	SL	A-6(1)	SC
	Ckgj	25-55	100	67	33	30	17	30	14	19.2	1.8	13.3	49.6	CoSL	A-2-6(0)	SC
Horod (SW 29-19-19W)	Bm	16-40	100	74	20	16	12	20	2	19.7	1.7	5.7	31.0	LS	A-2-4(0)	SM
Horod (SW 14-19-21W)	Ck1	30-60	100	41	21	18	10	24	3	21.6	1.7	7.3	36.8	LCoS	A-16(0)	SM
Kircro (SE 32-18-18W)	AC	65-77	100	90	49	43	22	39	20	18.0	1.8	15.0	56.0	SCL	A-6(6)	CL
Meadowbrook (NE 26-17-17W)	Bt	15-40	100	100	98	96	65	71	39	11.0	2.1	27.0	89.0	C	A-7-5(46)	CH
	CK1	60-80	100	100	99	96	46	83	48	18.0	1.8	27.0	105.0	SiC	A-7-5(58)	CH
Meadowbrook (NW 33-17-18W)	Bm	12-26	100	100	96	92	64	69	39	12.6	2.0	31.1	113.2	C	A-7-5(42)	CH
	Ck2	90-110	100	100	95	91	55	70	39	19.4	1.8	28.8	116.3	C	A-7-5(44)	CH
Ozerna (NE 8-19-19W)	Bt	15-33	100	84	34	29	20	25	9	18.7	1.8	10.4	40.0	SCL	A-2-4(0)	SC
	IICkg	85-100	100	79	57	52	18	29	13	17.4	1.9	15.3	50.8	L	A06(3)	SC
Proven Lake (NE 26-17-18W)	Cg2	65-100	100	100	77	56	29	40	22	17.0	1.9	18.0	62.0	CL	A-7-6(17)	CL
Reckham (SE 31-18- 9W)	Btj	15-23	100	98	87	81	28	41	17	18.8	1.8	19.7	71.0	SiCL	A-7-6(17)	CL
	Ckg2	70-100	100	99	84	74	16	33	11	23.5	1.6	13.8	57.8	SiL	A-4(9)	CL
Seech (SE 32-19-19W)	Bt	24-45	100	54	28	25	15	28	13	19.0	1.8	11.4	43.6	CoSL	A-2-6(0)	SC
Seech (NE 32-19-19W)	Bt	17-25	100	68	50	48	26	43	20	13.0	2.0	19.0	56.0	SCL	A-7-6(7)	CL
	Ck1	25-30	100	55	50	49	28	84	29	30.0	1.5	22.0	107.0	SCL	A-7-5(0)	SC
Swanford (SW 29-19-19W)	AC	25-40	100	92	76	63	28	36	19	18.0	1.9	18.7	63.8	CL	A-6(11)	CL
	Ckgj1	40-75	100	97	73	64	21	30	12	17.7	1.8	14.8	52.1	L	A-6(7)	CL
	Ckgj2	75-100	100	100	90	82	64	33	11	22.2	1.7	13.5	54.0	SiL	A-6(10)	CL
Swan (NE 30-18-19W)	AB	42-50	100	99	89	83	28	33	14	17.7	1.8	16.0	56.6	SiCL	A-6(12)	CL
	Btg	65-85	100	100	99	98	47	55	28	20.3	1.7	23.0	89.7	SiC	A-7-6(33)	CH
	Cg	85-105	100	100	98	97	40	57	29	20.2	1.7	24.1	97.5	SiC	A-7-6(35)	CH
	IICkg	105-120	100	94	81	77	28	47	24	19.4	1.8	21.4	78.7	CL	A-7-6(10)	CL
Valley (SW 18-18-17W)	Bt2	45-60	100	85	42	34	23	35	15	18.9	1.7	15.0	55.7	SCL	A-6(3)	SC
	Ckgj	80-100	100	96	69	59	30	37	17	29.5	1.8	15.2	65.7	CL	A-6(1)	CL
Vista (NW 20-19-18W)	Cg	50-70	100	88	19	13	10	N.P.	N.P.	20.0	1.7	3.0	25.0	LFS	A-2-4	SM
Zaparoza (SE 16-19-18W)	Btk	5-18	100	63	36	33	16	44	1	29.0	1.4	13.0	66.0	SL	A-2-4(0)	SC

Table 22. Engineering Description of Soils and Their Estimated Properties Significant to Engineering Uses

Map Symbol	Soil Series Name	Depth (cm)	Textural Classification			% Passing Sieve			Disturbed Hydraulic Conductivity (cm/hr)	Reaction (pH)	Dispersion*	Sulphate* Hazard	Shrink-Swell Potential*	Depth to Seasonal Water Table(m)
			USDA	Unified	AASHO	No. 10 2.0 mm	No. 40 0.42 mm	No. 200 0.074 mm						
BAN	Banks	0-20	L	CL	A-6	100	90-100	70-80	5-15	7.0-7.6	L	N	L	>2
		20-80	L	CL	A-6	100	90-100	75-95	5-15	7.0-7.6	L	N	L-M	
		80+	CL	CL	A-6	95-100	80-100	55-75	.5-5	7.4-8.2	L	N	L-M	
BHY	Bethany	0-15	LS	SM	A-2 to A-4	70-90	70-90	50-70	5-15	7.0-7.6	L	N	L	>1.5
		15-35	LS	SP	A-4	60-90	50-70	30-50	>15	7.4-8.2	L	N	L	
BKO	Breckon	0-100	SiC	A-7-6	CL	100	95-100	95-100	<0.15	7.0-8.0	L	L	M-H	<1
BWG	Bluewing	0-20	FS to LFS	SM	A-2-4,A-4	100	55-75	15-35	15-20	6.8-7.4	L	N	L	>1.5
		20-70	FSL-SCL	SM,SC	A-4,A-6	100	70-90	35-55	5-10	6.8-7.4	L	N	L-M	
		70+	LFS-FSL	SM	A-4	100	60-80	25-45	15-25	7.4-7.8	L	-	L	
BYH	Baynham	0-15	Fibric Peat	Pt	N	-	-	-	-	4.5-5.5	-	-	-	<1
		15-170	Mesic Peat	Pt	-	-	-	-	-	5.5-7.0	-	N	-	
		170+	L-C	ML to CH	A-4,A-7	100	100	70-90	<0.5	7.5-8.0	L	L	M-H	
CAY	Cayer	0-40	Mesic Peat	Pt	-	-	-	-	-	6.0-7.0	-	N	-	<1
		40+	L-CL Till	ML to CH	A-4,A-7-6	100	100	70-90	0.1-5.0	7.5-8.0	L	L	M-H	
DKS	Dickson	0-20	FSL	SM	A-2-4	100	55-75	15-35	5-15	7.0-7.6	L	L	L	>2
		20-60	LS	SW	A-4	80-100	60-95	25-45	15-50	7.4-7.8	L	L	L	
		60-100	L-CL	CL	A-6	90-95	80-100	50-75	.5-5.0	7.4-8.2	L	-	L-M	
DVD	Davidson	0-25	LFS	SM	A-2-4	100	55-75	15-35	>15	6.8-7.4	L	L	L	>2
		25-70	FSL-SCL	SM-SC	A-4	100	70-90	35-55	5-15	6.8-7.4	L	N	L	
		70+	LFS-FS	SM	A-2-4	100	60-80	25-45	>15	7.4-7.8	L	N	L	
ECK	Erickson	0-20	CL	CL	A-6	95-100	85-100	60-80	5-15	7.0-7.6	L	N	M-H	>1.5
		20-40	C	CL,CH	A-6,A-7	95-100	85-100	70-95	<.5	7.0-7.6	L	N	H	
		40+	L-CL	CL	A-6	90-95	80-100	55-75	1.5-5	7.4-8.2	L	N	L-M	
HEC	Heron Creek	0-30	SL	SC	A-6(1)	90-100	60-90	50-60	5-15	7.0-7.6	L	N	L	<1.5
		30+	S-Gr	GM-GP	A-1	30-50	30-40	0-15	>15	7.4-8.1	L	N	L	

Table 22. Engineering Description of Soils and Their Estimated Properties Significant to Engineering Uses

Map Symbol	Soil Series Name	Depth (cm)	Textural Classification			% Passing Sieve			Disturbed Hydraulic Conductivity (cm/hr)	Reaction (pH)	Dispersion*	Sulphate* Hazard	Shrink-Swell Potential*	Depth to Seasonal Water Table(m)
			USDA	Unified	AASHO	No. 10 2.0 mm	No. 40 0.42 mm	No. 200 0.074 mm						
HRD	Horod	0-15	LS	SP	A-4	100	75-100	30-50	5-15	7.0-7.6	L	N	L	>1.5
		15-30	LS	SM	A-2-4	100	60-85	15-30	>15	7.4-8.4	L	N	L	
		30-60	LCoS	SM	A-16	100	35-50	15-30	>15	7.4-8.4	L	N	L	
KHI	Katherine	0-25	L	CL	A-4 to A-6	70-90	70-90	50-70	5-15	7.0-7.6	L	N	L	>2.0
		25-75	SCL	SM	A-4	60-85	50-70	30-50	>15	7.4-8.2	L	N	L	
KIC	Kircrow Series	0-115	Mesic Peat	Pt	-	-	-	-	-	6.0-7.0	-	-	-	<1
		115+	Sand	SP	A-3	100	90-100	10-20	15-50	7.5-8.0	L	N	L	
LSW	Lenswood	0-30	FSL	SM	a-4	100	70-85	40-55	10-15	7.0-7.6	L	N	L	.7-1.2
		30+	LFS-FSL	SM	A-4	100	60-80	25-45	15-50	7.4-7.8	L	N	L	
MHC	Marsh Complex	20+	CL	CL,OL	A-7	100	90-100	70-90	<.5	7.4-8.4	M	L	H	<.5
MWK	Meadowbrook	0-15	C	CH	A-7-5	100	100	90-100	.15-.5	7.0-7.6	L	N	M-H	>1.5
		15-40	C	CH	A-7-5	100	100	90-100	.15-.5	7.0-7.6	L	N	M-H	
		40-80	SiC	CH	A-7-5	100	100	90-100	.5-.15	7.4-7.8	L	N	M	
OKO	Okno Complex	0-30	Fibric Peat	Pt	-	-	-	-	-	5.5-6.0	-	-	-	<1
		-120	Mesic Peat	Pt	-	-	-	-	-	6.0-7.0	-	-	-	
		120+	L-C	ML-CH	A-4,A-7-6	100	100	70-90	5-15	7.4-8.0	L	L	M-H	
OOL	Onanole	0-20	CL	CL	A-6	100	90-100	70-80	5-15	7.0-7.6	L	L	M	>1.5
		20-40	C	CL,CH	A-6,A-7	100	90-100	75-95	<2	7.0-7.6	L	L	H	
		40+	SiCL	CL	A-6,A-7	100	95-100	85-95	5-10	7.4-8.2	L	L	M	
OZA	Ozerna	0-20	FSL	SM	A-2-4	100	55-75	15-35	5-15	7.0-7.6	L	L	L	>2
		20-70	LS	SW	A-4	80-100	60-80	25-45	15-50	7.4-7.8	L	L	L	
		70-100	L-CL	CL	A-6	90-95	80-100	55-75	.5-5	7.4-8.2	L	L	L-M	
PPL	Poppleton	0-40	FSL	SM	A-4	100	70-85	40-55	5-15	7.0-7.6	L	L	L	.7-1.2
		40+	LFS-FSL	SM	A-4	100	60-80	25-45	15-50	7.4-7.8	L	L	L	

Table 22. Engineering Description of Soils and Their Estimated Properties Significant to Engineering Uses

Map Symbol	Soil Series Name	Depth (cm)	Textural Classification			% Passing Sieve			Disturbed Hydraulic Conductivity (cm/hr)	Reaction (pH)	Dispersion*	Sulphate* Hazard	Shrink-Swell Potential*	Depth to Seasonal Water Table(m)
			USDA	Unified	AASHO	No. 10 2.0 mm	No. 40 0.42 mm	No. 200 0.074 mm						
PTU	Petlura	0-20	CL	CL	A-6	95-100	85-100	60-80	5-15	7.0-7.6	L	L	L	>1
		20-50	CL	CL	A-6	95-100	85-100	70-95	<.5	7.0-7.6	L	L	L-M	
		50+	CL	CL	A-6	90-95	80-100	55-75	1.5-5	7.4-8.2	L	L	L	
PVk	Proven Lake	0-20	CL-C	OL	A-7	100	90-100	70-90	<.5	7.0-7.6	L	L	M-H	<1
PVKp	Proven Lake	0-30	Peat	Pt	-	-	-	-	-	7.4-7.8	-	N	-	-
	peaty	30-50	CL-C	OL	A-7	100	90-100	70-90	<.5	7.0-7.6	L	L	M	<1
	phase	50+	C-SiC	CL,CH	A-7	100	90-100	80-95	-	7.4-8.2	L	L	H	
RBN	Roblin	0-40	L	CL	A-6	95-100	85-100	60-80	5-15	6.8-7.4	L	L	M	>3
		40-80	C	CL	A-6	100	85-100	70-95	.5-1.5	7.0-7.6	L	L	H	<1
		80+	L-CL	CL	A-6	90-95	85-100	55-75	.5-1.5	7.4-7.6	L	L	L-M	
RKH	Rackham	0-20	SCL-CL	CL	A-4,A-6	100	85-95	50-75	5-.5	6.8-7.4	L	L	L-M	>1.5
		20-50	C	CL,CH	A-6,A-7	100	90-100	75-95	<2	6.8-7.4	L	L	H	
		50+	SiCL	CL	A-6,A-7	100	95-100	85-95	5-15	7.4-7.8	L	L	M	
RTV	Rat River	0-75	Mesic peat	Pt						6.5-7.2	N	N	-	<1
	Complex	75-95	LFS	SW to SP	A-2,A-4	100	85-95	15-35	15-50	72.-7.4	L	L	N	
		95+	FS	SM to SP	A-2	100	85-95	30-150	15-50	7.4-7.8	L	L	N	
SOB	Sand beach	20+	FS	SM-SP	A-2	100	85-95	30-50	15-50	7.4-7.8	L	L	L	<.5
SHH	Seech	0-20	SL	SC	A-6	100	75-100	50-75	5-15	7.0-7.6	L	N	N	>2
		20-35	SCL	CL	A-7-6	100	50-75	40-60	>15	7.4-8.2	L	N	N	
		35-50	Co	SM-SP	A-2,A-4	100	50-75	40-60	>15	7.4-8.2	L	N	N	
SHH(c)	Seech	0-20	SL	SC	A-6	100	75-100	50-75	5-15	7.0-7.6	L	N	N	>2
	variant	25-60	CoSL	SM-SP	A-2 to A-4	100	50-75	40-60	>15	7.4-8.2	L	L	N	
SNTp	Sinnott	0-30	Peat	Pt	-	-	-	-	-	7.3-7.8	N	N	-	<1
	peaty	30-50	CL	OL	A-7	100	90-100	70-80	.5-1.5	7.0-7.6	L	L	M	
	phase	50+	CL-C	CL	A-6,A-7	95-100	85-100	70-90	.5-1.5	7.4-8.2	L	L	M-H	

Table 22. Engineering Description of Soils and Their Estimated Properties Significant to Engineering Uses

Map Symbol	Soil Series Name	Depth (cm)	Textural Classification			% Passing Sieve			Disturbed Hydraulic Conductivity (cm/hr)	Reaction (pH)	Dispersion	Sulphate Hazard	Shrink-Swell Potential	Depth to Seasonal Water Table(m)
			USDA	Unified	AASHO	No. 10 2.0 mm	No. 40 0.42 mm	No. 200 0.074 mm						
STD	Stead	0-160	Mesic Peat	Pt	-	-	-	-	-	6.5-7.0	L	N	-	<1
		160+	L-C	ML to CH	A-4,A-7	100	100	70-90	0.05	7.6-8.0	L	N	M-H	
SWF	Swanford	0-30	SiL	ML	A-4	100	100	90-95	1.3-5.0	6.5-7.5	L	L	M	
		30-70	VFSL	ML	A-4	100	100	75-95	1.2-5.0	7.5-8.5	L	L	M	
SWN	Swan	0-20	L-CL	CL	A-6	100	90-100	70-80	5-15	7.0-7.6	L	L	M	<1
		20-40	CL-C	CL,CH	A-6,A-7	100	90-100	75-95	<.5	7.0-7.6	L	L	M	
		40+	SiCL	CL	A-6,A-7	100	95-100	85-95	5-15	7.4-8.0	L	L	M	
TEK	Tew Lake	0-15	FSL-L	CL	A-4	80-85	-	-	0.15-5.0	-	L	L	L	<1.5
		20-35	SCL	CL	A-6	85-95	75-85	50-55	0.15-5.0	6.0-7.5	L	L	M	
		35+	L	CL	A-6	80-85	70-75	45-50	0.13-5.0	7.0-8.0	L	L	L-M	
VLY	Valley	0-25	SiL	ML	A-4	100	100	90-95	1.5-5.0	6.6-7.2	L	L	M	>1.0
		25-60	VFSL	ML	A-4	100	100	75-95	1.3-5.0	7.5-8.0	L	L	M	
VST	Vista	0-20	FSL-FSCL	SM,SC	A-4,A-6	100	70-90	35-55	-	7.0-7.6	L	L	L-M	<1
		20+	LFS-FSL	SM	A-4	100	60-80	25-45	15-50	7.4-7.8	L	L	L	
VSTp	Vista peaty phase	0-30	Peat	Pt	-	-	-	-	-	7.3-7.8	-	-	-	<1
		30-50	FSL-FSCL	SM,SC	A-4,A-6	100	70-90	35-55	5-15	7.0-7.6	-	-	L-M	
		50+	LFS-FSL	SM	A-4	100	60-80	25-45	-	7.4-7.8	L	L	L	
WLM	Wellman	0-20	C	CH	A-7-5	100	100	90-100	.15-.5	7.0-7.6	L	L	M-H	<2
		20+	C	CH	A-7-5	100	100	90-100	<.15	7.4-8.0	L	L	H	
WPU	Wapus	0-15	CL	CL	A-4,A-6	95-100	85-100	60-80	<1.5	7.0-7.6	L	L	L-M	>2
WTV	Waitville	0-20	CL	CL	A-6	95-100	85-100	60-80	5-15	6.8-7.0	L	N	L	>3
		20-50	C	CH	A-7-5	95-100	85-100	70-95	<.5	7.0-6.6	L	N	M	
		50+	CL	CL	A-6	90-95	85-100	55-75	1.5-5	7.4-8.2	L	L	L	
		15-35	C	CL-CH	A-6,A-7	95-100	85-100	70-95	<1.5	7.0-7.6	L	L	H	
		35-60	C	CL-CH	A-6,A-7	90-95	85-100	55-75	1.5-5	7.4-8.0	L	L	H	

Table 22. Engineering Description of Soils and Their Estimated Properties Significant to Engineering Uses

Map Symbol	Soil Series Name	Depth (cm)	Textural Classification			% Passing Sieve			Disturbed Hydraulic Conductivity (cm/hr)	Reaction (pH)	Dispersion*	Sulphate* Hazard	Shrink-* Swell Potential	Depth to Seasonal Water Table(m)
			USDA	Unified	AASHO	No. 10 2.0 mm	No. 40 0.42 mm	No. 200 0.074 mm						
ZAP	Zaparosa	0-15	SL-LS	SM	A-2-4	75-95	50-70	20-40	15-20	6.8-7.4	L	N	L	>1.5
		15+	Gr	GP,GW	A-1	30-65	-	0-5	>50	7.4-8.0	L	N	L	

* L=low, M=moderate, H=high N=soil

TABLE. 23 SUITABILITY RATINGS OF SOILS FOR SELECTED ENGINEERING USES

Map Symbol and Phase		Soil Name	Top Soil	Sand & Gravel	Road Fill	Permanent Bldgs. With Basements	Local Roads and Streets	Sanitary Trench	Landfill Area	Cover Material	Sewage Lagoons	Septic Fields
BAX		Banks	Fb	Va	Fa	Fa	Fa	G	G	G	Fk	Fk
BAX	/xc1x	Banks	Fb	Va	Fa	Fa	Fa	G	G	G	Fk	Fk
BAX	/xc2x	Banks	Fb	Va	Fa	Fa	Fa	G	G	G	Fk	Fk
BAX	/xc3x	Banks	Fb	Va	Fa	Fa	Fa	G	G	G	Fk	Fk
BHY		Bethany	Ps	G	G	Pw	Fw	Vws	Vk	Vws	Ps	Pkg
BKO		Breckon	Ps	Va	Pwl	Vwf	Pwf	Vw	Pw	Psw	G	Vkh
BMG		Blue Wing	Ps	Ps	G	G	G	Vsk	Vk	Vs	Vk	Gg
BMG	/xcxx	Blue Wing	Ps	Ps	G	G	G	Vsk	Vk	Vs	Vk	Gg
BMG	/xexx	Blue Wing	Pst	Ps	G	Ft	Ft	Vsk	Vk	Vst	Vkt	Ftg
BMG	/2exx	Blue Wing	Pst	Ps	G	Ft	Ft	Vsk	Vk	Vst	Vkt	Ftg
BMG	/3exx	Blue Wing	Pst	Ps	G	Ft	Ft	Vsk	Vk	Vst	Vkt	Ftg
BYH		Baynhaa	Pws	Va	Va	Vaw	Vaw	Vsw	Vwh	Vsw	Vah	Vhg
CAY		Cayer	Vw	Va	Vaw	Vaw	Vaw	Vsw	Vkw	Vsw	Vah	Vh
DKS		Dickson	Ps	Ps	Fw	Pw	Fw	Pw	Pk	Fs	Pka	Ph
DVD		Davidson	Ps	Fa	G	G	G	Vsk	Vk	Vs	Vk	Gg
DVD	/xcxx	Davidson	Ps	Fa	G	G	G	Vsk	Vk	Vs	Vk	Gg
DVD	/xc1x	Davidson	Ps	Fa	G	G	G	Vsk	Vk	Vs	Vk	Gg
DVD	/xdxx	Davidson	Ps	Ps	G	G	G	Vsk	Vk	Vs	Vk	Gg
DVD	/xd1x	Davidson	Ps	Ps	G	G	G	Vsk	Vk	Vs	Vk	Gg
DVD	/xexx	Davidson	Pst	Ps	G	Ft	Ft	Vsk	Vk	Vts	Vkt	Gg
DVD	/xfxx	Davidson	Pst	Ps	G	Ft	Ft	Vsk	Vk	Vts	Vkt	Ftg
DVD	/1cxx	Davidson	Ps	Fa	G	G	G	Vsk	Vk	Vs	Vk	Gg
DVD	/1fxx	Davidson	Pst	Ps	G	Ft	Ft	Vsk	Vkt	Vts	Vkt	Ftg
DVD	/1f1x	Davidson	Pst	Ps	G	Ft	Ft	Vsk	Vkt	Vts	Vkt	Ftg
DVD	/2fxx	Davidson	Pst	Ps	G	Ft	Ft	Vsk	Vkt	Vts	Vkt	Ftg
DVD	/3dxx	Davidson	Psb	Ps	G	G	G	Vsk	Vk	Vs	Vk	Gg
ECK		Erickson	Fs	Va	Fa	Fa	Fa	Fs	G	Fs	Fk	Fk
ECK	/xcxx	Erickson	Fs	Va	Fa	Fa	Fa	Fs	G	Fs	Fkt	Fk
ECK	/xc1x	Erickson	Fs	Va	Fa	Fa	Fa	Fs	G	Fs	Fkt	Fk
ECK	/xc2x	Erickson	Fsp	Va	Fa	Fsp	Fa	Fs	G	Fsp	Fkt	Fk

TABLE.23 SUITABILITY RATINGS OF SOILS FOR SELECTED ENGINEERING USES

Map Symbol and Phase	Soil Name	Top Soil	Sand & Gravel	Road Fill	Permanent Bldgs. With Basements	Local Roads and Streets	Sanitary Trench	Landfill Area	Cover Material	Sewage Lagoons	Septic Fields
ECK /xc3x	Erickson	Fbp	Va	Fa	Fa	Fa	Fs	G	Fs	Fkt	Fk
ECK /xdxx	Erickson	Fst	Va	Fa	Fa	Fa	Fs	G	Fs	Pt	Pk
ECK /xd1x	Erickson	Fst	Va	Fa	Fa	Fa	Fs	G	Fs	Pt	Fk
ECK /xd2x	Erickson	Ftp	Va	Fa	Fap	Fa	Fs	G	Fsp	Pt	Fk
ECK /xd3x	Erickson	Pp	Va	Fap	Pp	Fap	Fsp	G	Pp	Pt	Fk
ECK /xexx	Erickson	Pts	Va	Fa	Fat	Fta	Fs	Ft	Fst	Vt	Fkt
ECK /xe3x	Erickson	Ptp	Va	Fa	Fat	Fta	Fs	Ft	Fst	Vt	Fkt
ECK /xf1x	Erickson	Vtb	Va	Fa	Fta	Pta	Fst	Pt	Pts	Vt	Ptk
ECK /xf2x	Erickson	Vt	Va	Fat	Pt	Pt	Ft	Pt	Pt	Vt	Pt
ECK /1cxx	Erickson	Fsb	Va	Fa	Fa	Fa	Fs	G	Fs	Fkt	Fk
ECK /1c2x	Erickson	Fbs	Va	Fa	Fa	Fa	Fs	G	Fs	Fk	Fk
ECK /1dxx	Erickson	Fst	Va	Fa	Fa	Fa	Fs	G	Fs	Pt	Fk
ECK /1d1x	Erickson	Fst	Va	Fa	Fa	Fa	Fs	G	Fs	Pt	Fk
ECK /1d2x	Erickson	Fst	Va	Fa	Fa	Fa	Fs	G	Fs	Pt	Fk
ECK /1exx	Erickson	Ptb	Va	Fa	Fta	Fta	Fs	Ft	Fst	Vt	Fkt
ECK /1e1x	Erickson	Ptb	Va	Fa	Fta	Fta	Fs	Ft	Fst	Vt	Fkt
ECK /1e3x	Erickson	Ptp	Va	Fa	Ftp	Ftp	Fs	Ft	Fst	Vt	Fkt
ECK /2dxx	Erickson	Fst	Va	Fa	Fa	Fa	Fs	G	Fs	Pt	Fk
ECK /2d1x	Erickson	Fst	Va	Fa	Fa	Fa	Fs	G	Fs	Pt	Fk
ECK /2d2x	Erickson	Fst	Va	Fa	Fa	Fa	Fs	G	Fs	Pt	Fk
ECK /2e1x	Erickson	Pts	Va	Fa	Fta	Fta	Fs	Ft	Fst	Vt	Fkt
ECK /2e3x	Erickson	Ptp	Va	Fa	Ftp	Ftp	Fs	Ft	Fst	Vt	Fkt
ECK /2fxx	Erickson	Vts	Va	Pat	Pta	Pta	Fst	Pt	Pts	Vt	Ptk
ECK /2f1x	Erickson	Vts	Va	Pat	Pta	Pta	Fst	Pt	Pts	Vt	Ptk
ECK /3d2x	Erickson	Fbt	Va	Fa	Fa	Fa	Fs	G	Fs	Pt	Fk
ECK /3d4x	Erickson	Fbt	Va	Fa	Fa	Ppa	Fs	G	Fs	Ptp	Fk
ECK /3e2x	Erickson	Ptb	Va	Fa	Fta	Fta	Fs	Ft	Fst	Vt	Fkt
ECK /3f1x	Erickson	Vtb	Va	Pat	Pta	Pta	Fts	Pt	Fst	Vts	Ptk
HEC	Heron Creek	Fsi	G	Pwf	Vwi	Pwi	Vws	Vhw	Vsw	Vkh	Vki
HECp	Heron Creek	Fsi	G	Pwf	Vwi	Pwi	Vws	Vhw	Vsw	Vkh	Vki

TABLE. 23 SUITABILITY RATINGS OF SOILS FOR SELECTED ENGINEERING USES

Map Symbol and Phase	Soil Name	Top Soil	Sand & Gravel	Road Fill	Permanent Bldgs. With Basements	Local Roads and Streets	Sanitary Trencn	Landfill Area	Cover Material	Sewage Lagoons	Septic Fields
HRD	Horod	Fsi	G	Fwf	Pwi	Fwi	Vsk	Pki	Vs	Pa	Pk
KHI	Katherine	Ps	G	G	Pw	Fw	Vws	Vk	Vpu	Pa	Pkg
KHI /xcxx	Katherine	Ps	G	G	Pw	Fw	Vws	Vk	Vpu	Pa	Pkg
KHI /xc3x	Katherine	Psp	G	G	Pwp	Fwp	Vws	Vk	Vp	Pa	Pkg
KIC	Kircro	Vw	Va	Vaw	Vaw	Vaw	Vsw	Vkw	Vsw	Vah	Vhg
LSW	Lenswood	Ps	Fa	Fw	Pw	Fw	Vsk	Vk	Vs	Vk	Phg
LSW /xcxx	Lenswood	Ps	Fa	Fw	Pw	Fw	Vsk	Vk	Vs	Vk	Phg
MWK	Meadowbrook	Ps	Va	Pa	Pa	Pa	Ps	G	Ps	G	Fk
MWK /xcxx	Meadowbrook	Ps	Va	Pa	Pa	Pa	Ps	G	Ps	Ft	Fk
OKO	Okno	Vw	Va	Vwa	Vha	Va	Vws	Vw	Vsw	Vai	Vh
OOL	Onanole	G	Va	Fa	Fa	Fa	Fs	G	G	Fk	Fk
OOL /xcxx	Onanole	G	Va	Fa	Fa	Fa	Fs	G	G	Fkt	Fk
OOL /xdxx	Onanole	Ft	Va	Fa	Fa	Fa	Fs	G	G	Pt	Fk
OOL /1dxx	Onanole	Ft	Va	Fa	Fa	Fa	Fs	G	G	Pt	Fk
OOL /2dxx	Onanole	Ft	Va	Fa	Fa	Fa	Fs	G	G	Pt	Fk
OOL /2exx	Onanole	Pt	Va	Fa	Fat	Fa	Fs	G	Ft	Vt	Fkt
OZA	Ozerna	Fb	Va	Fa	Fa	Fa	Fs	Pk	Fs	Fk	Fkg
OZA /xcxx	Ozerna	Fb	Va	Fa	Pa	Fa	Fs	Pkg	Fs	Vk	Fkg
OZA /xc2x	Ozerna	Fp	Va	Fa	Fa	Fa	Fs	Pkg	Fsp	Fkt	Fkg
OZA /xdxx	Ozerna	Ft	Va	Fa	Fa	Fa	Fs	Pkg	Fs	Pt	Fkg
OZA /xexx	Ozerna	Ptb	Va	Fa	Ft	Fta	Fs	Pkg	Fst	Vkt	Fkg
PPL	Poppleton	Ps	Fa	Fw	Pw	Fw	Vks	Vk	Vs	Vk	Phg
PPL /xcxx	Poppleton	Ps	Fa	Fw	Pw	Fw	Vks	Vkg	Vs	Vk	Phg
PPL /xfxx	Poppleton	Vts	Fa	Ftw	Pwt	Ptw	Vks	Vkg	Vs	Vkt	Phg
PTU	Petlura	Fs	Va	Pa	Pw	Fwa	Pw	Fw	Fs	Fk	Fk
PTU /xcxx	Petlura	Fs	Va	Pa	Pw	Fwa	Pw	Fw	Fs	Fk	Fk
PTU /xc1x	Petlura	Fs	Va	Pa	Pw	Fwa	Pw	Fw	Fs	Fk	Fk
PVK	Proven Lake	Fb	Va	Pwa	Pw	Pw	Vw	Pw	Pw	Ph	Va
PVKp	Proven Lake	Fb	Va	Pwa	Pw	Pw	Vw	Pw	Pw	Ph	Va
PVK /xxxs	Proven Lake	Pbn	Va	Pwa	Pw	Pw	Vw	Pw	Pw	Ph	Va

TABLE. 23 SUITABILITY RATINGS OF SOILS FOR SELECTED ENGINEERING USES

Map Symbol and Phase	Soil Name	Top Soil	Sand & Gravel	Road Fill	Permanent Bldgs. With Basements	Local Roads and Streets	Sanitary Trench	Landfill Area	Cover Material	Sewage Lagoons	Septic Fields
RBH	Roblin	Fsb	Va	Paf	Pwa	Pwf	Vw	Pw	Pws	Pkh	Vkh
RKH	Rackham	Fs	Va	Pa	Fa	Fa	Fs	G	Fs	Fk	G
RKH /xdxx	Rackham	Fst	Va	Pa	Fa	Fa	Fs	G	Fs	Pt	G
RKH /2exx	Rackham	Pt	Va	Pa	Fat	Fat	Fs	Ft	Fst	Vt	G
RTV	Rat River	Pws	Va	Va	Vaw	Vaw	Vws	Vwh	Vsw	Vah	Vhg
SHH	Seech	Ps	G	G	G	G	Vsk	Vkg	Vs	Vk	Gg
SHH /xx2x	Seech	Ps	G	G	G	G	Vsk	Vkg	Vs	Vk	Gg
SHH /xcxx	Seech	Ps	G	G	G	G	Vsk	Vkg	Vs	Vkt	Gg
SHH /xc1x	Seech	Ps	G	G	G	G	Vsk	Vkg	Vs	Vkt	Gg
SHH /xc3x	Seech	Ps	G	G	G	G	Vsk	Vkg	Vs	Vkt	Gg
SHH /xdxx	Seech	Ps	G	G	G	G	Vsk	Vdg	Vs	Vkk	Gg
SHH /xd3x	Seech	Ps	G	G	G	G	Vsk	Vkg	Vs	Vkt	Gg
SHH /xexx	Seech	Pst	G	G	Ft	Ft	Vsk	Vkg	Vs	Vkt	Gg
SHH /xfxx	Seech	Pst	G	G	Pt	Pt	Vsk	Vkg	Vs	Vkt	Ftg
SHH /1e1x	Seech	Pst	G	G	Ft	Ft	Vsk	Vkg	Vs	Vkt	Ftg
SHH /1e2x	Seech	Fst	G	G	Ft	Ft	Vsk	Vkg	Vs	Vkt	Ftg
SHH /1e3x	Seech	Pst	G	G	Ft	Ft	Vsk	Vkg	Vs	Vkt	Ftg
SHH /1fxx	Seech	Pst	G	G	Ft	Ft	Vsk	Vkg	Vs	Vkt	Ptg
SHH /2e2x	Seech	Psb	G	G	Ft	Ft	Vsk	Vkg	Vs	Vkt	Ftg
SHHc	Seech	Ps	G	G	G	G	Vsk	Vkg	Vs	Vk	Gg
SNT	Sinnott	Fs	Va	Pwa	Pwa	Pwa	Vw	Pw	Pw	Fk	Vh
SNT /xx2x	Sinnott	Fs	Va	Pwa	Vwa	Pwa	Vwi	Pw	Pw	Ph	Vh
SNTp	Sinnott	Fs	Va	Pwa	Pwa	Pwa	Vw	Pw	Pw	Ph	Vh
STD	Stead	Vws	Va	Va	Vaw	Vaw	Vws	Vwh	Vsw	Vah	Vha
SWF	Swanford	G	Va	Faw	Pw	Fwa	Pw	Fw	G	Fka	Ph
SWN	Swan	Fs	Va	Pa	Pw	Faw	Pw	Fw	Fs	Fk	Fh
SWN /xcxx	Swan	Fs	Va	Pa	Pw	Faw	Pw	Fw	Fs	Fk	Fh
TEK	Tee Lake	Fs	Va	Pa	Pwa	Faw	Pw	Fw	Fs	Fk	Fkh
TEK /xc3x	Tee Lake	Fsp	Va	Pa	Pwa	Faw	Pw	Fw	Fs	Fkt	Fkh
TEK /xx2x	Tee Lake	Fs	Va	Pa	Pwa	Faw	Pw	Fw	Fs	Fk	Fkh

TABLE.23 SUITABILITY RATINGS OF SOILS FOR SELECTED ENGINEERING USES

Map Symbol and Phase	Soil Name	Top Soil	Sand & Gravel	Road Fill	Permanent Bldgs. With Basements	Local Roads and Streets	Sanitary Trench	Landfill Area	Cover Material	Sewage Lagoons	Septic Fields
VLY	Valley	Fs	Va	Pa	Pw	Faw	Pw	Fw	Fs	Fka	Phk
VLY /xcxx	Valley	Fs	Va	Pa	Pwa	Faw	Fw	Fw	Fs	Fkt	Fkh
VST	Vista	Pw	Va	Pw	Pw	Pw	Vws	Vkg	Vsw	Vhk	Vhi
VSTp	Vista	Pws	Va	Pw	Vw	Pw	Vws	Vkg	Vsw	Vhk	Vhi
WLM	Wellman	Ps	Va	Pa	Pa	Pa	Ps	G	Ps	G	Fk
WTV	Waitville	Fs	Va	Pa	Fa	Fa	Fs	G	Fs	Fk	Fk
WTV /xx3x	Waitville	Pp	Va	Pa	Pp	Fap	Pp	G	Pp	Fk	Fk
WTV /xcxx	Waitville	Fs	Va	Pa	Fa	Fa	Fs	G	Fs	Fkt	Fk
WTV /xc1x	Waitville	Fs	Va	Pa	Fa	Fa	Fs	G	Fs	Fkt	Fk
WTV /xc2x	Waitville	Fs	Va	Pa	Fa	Fa	Fs	G	Fs	Fkt	Fk
WTV /xc3x	Waitville	Fsp	Va	Pa	Fa	Fa	Pp	G	Fs	Fkt	Fk
WTV /xdxx	Waitville	Fs	Va	Pa	Fa	Fa	Fs	G	Fs	Pt	Fk
WTV /xd1x	Waitville	Fst	Va	Pa	Fa	Fa	Fs	G	Fs	Pt	Fk
WTV /xd2x	Waitville	Fst	Va	Pa	Fa	Fa	Fs	G	Fs	Pt	Fk
WTV /xexx	Waitville	Pt	Va	Pa	Fat	Fat	Fs	Ft	Fst	Vt	Fkt
WTV /xe1x	Waitville	Pt	Va	Pa	Fat	Fat	Fs	Ft	Fs	Vt	Fkt
WTV /xe2x	Waitville	Pt	Va	Pa	Fat	Fat	Fs	Ft	Fs	Vt	Fkt
WTV /xe3x	Waitville	Ptp	Va	Pa	Fat	Fat	Pp	Ft	Fs	Vt	Fkt
WTV /xfxx	Waitville	Vt	Va	Pa	Pt	Pt	Fst	Pt	Pt	Vt	Pt
WTV /xf1x	Waitville	Vt	Va	Pa	Pta	Pwt	Fst	Pt	Pts	Vt	Pt
WTV /xf3x	Waitville	Vtp	Va	Pa	Pta	Pwt	Ppt	Pt	Pts	Vt	Pt
WTV /xg2x	Waitville	Vt	Va	Pat	Vt	Vt	Pts	Vt	Vt	Vt	Vt
WTV /1d2x	Waitville	Fst	Va	Pa	Fa	Fa	Fs	G	Fs	Pt	Fk
WTV /1exx	Waitville	Pt	Va	Pa	Fat	Fat	Fs	Ft	Fs	Vt	Fkt
WTV /1e2x	Waitville	Pt	Va	Pa	Fat	Fat	Fs	Ft	Fs	Vt	Fkt
WTV /1f1x	Waitville	Vt	Va	Pa	Pt	Pt	Fst	Pt	Pts	Vt	Pt
WTV /2c1x	Waitville	Fsb	Va	Pa	Fa	Fa	Fs	G	Fs	Fkt	Fk
WTV /2d2x	Waitville	Pbs	Va	Pa	Fa	Fa	Fs	G	Fs	Pt	Fk
WTV /2e1x	Waitville	Pbs	Va	Pa	Fa	Fa	Fs	G	Fs	Pt	Fk
WTV /2e2x	Waitville	Ptb	Va	Pa	Fa	Fta	Fs	Ft	Fs	Vt	Fkt

TABLE.23 SUITABILITY RATINGS OF SOILS FOR SELECTED ENGINEERING USES

Map Symbol and Phase	Soil Name	Top Soil	Sand & Gravel	Road Fill	Permanent Bldgs. With Basements	Local Roads and Streets	Sanitary Trench	Landfill Area	Cover Material	Sewage Lagoons	Septic Fields
WTV /2e3x	Waitville	Ptb	Va	Pa	Fa	Fta	Pp	Ft	Fs	Vt	Fkt
WTV /2f1x	Waitville	Vtb	Va	Pa	Pta	Pt	Fst	Pt	Pts	Vt	Pt
WTV /2f2x	Waitville	Vtb	Va	Pa	Pta	Pt	Fst	Pt	Pts	Vt	Pt
ZAP	Zaporosa	Ps	G	G	G	G	Vsk	Vkg	Vs	Vk	Gg
ZAP /xd1x	Zaporosa	Ps	G	G	G	G	Vsk	Vkg	Vs	Vk	Gg
ZAP /xd2x	Zaporosa	Ps	G	G	G	G	Vsk	Vkg	Vs	Vk	Gg
ZAP /xexx	Zaporosa	Pst	G	G	Ft	Ft	Vsk	Vkg	Vs	Vkt	Ftg
ZAP /xe1x	Zaporosa	Pst	G	G	Ft	Ft	Vsk	Vkg	Vs	Vkt	Ftg
ZAP /xe2x	Zaporosa	Pst	G	G	Ft	Ft	Vsk	Vkg	Vs	Vkt	Ftg
ZAP /xe3x	Zaporosa	Pst	G	G	Ft	Ft	Vsk	Vkg	Vs	Vkt	Ftg
ZAP /xf2x	Zaporosa	Vts	G	G	Ft	Ft	Vsk	Vkg	Vs	Vkt	Ptg
ZAP /1dxx	Zaporosa	Ps	G	G	G	G	Vsk	Vkg	Vs	Vk	Gg
ZAP /1d2x	Zaporosa	Ps	G	G	G	G	Vsk	Vkg	Vs	Vk	Gg
ZAP /2d2x	Zaporosa	Psb	G	G	G	G	Vsk	Vkg	Vs	Vk	Gg
ZAP /2exx	Zaporosa	Psb	G	G	Ft	Ft	Vsk	Vkg	Vs	Vkt	Ftg
ZAP /3e1x	Zaporosa	Psb	G	G	Ft	Ft	Vsk	Vkg	Vs	Vkt	Ftg
ZAP /3e2x	Zaporosa	Psb	G	G	Ft	Ft	Vsk	Vka	Vs	Vkt	Ftg
ZAP /3f1x	Zaporosa	Vtb	G	G	Ft	Ft	Vsk	Vkg	Vs	Vkt	Ftg

4.5 SOIL SUITABILITY FOR SELECTED RECREATION USES

This section provides interpretations of the soil suitability for recreational development. All kinds of soil can be used for recreational activities of some kind.

Soils and their properties determine to a large degree, the type and location of recreational facilities. Wet soils are not suitable for campsites, roads, play grounds or picnic areas. Soils that pond and dry out slowly after heavy rains present problems where intensive use is contemplated. It is difficult to maintain grass cover for playing fields and golf courses on droughty soils. The feasibility of many kinds of outdoor activities are determined by other basic soil properties such as depth to bedrock, stoniness, topography or land pattern, and the ability of the soil to support vegetation of different kinds as related to its natural fertility.

The suitability of the various soil series and phases for selected recreation uses is shown in Table 24 according to four classes, Good, Fair, Poor and Very poor defined previously in the section on Engineering Uses. Subclasses are employed to identify the kind of limitation or hazard for a particular use. An explanation of subclass symbols are provided in Table 19.

The guidelines for various recreation uses are presented in Appendix E, Tables 36 through 39.

TABLE. 24 SUITABILITY RATINGS OF SOILS FOR RECREATIONAL USES

Map Symbol and Phase	Soil Name	Play Ground	Picnic Area	Camp Area	Path And Trails	Permanent Bldgs. Without Basements
BAX	Banks	G	G	G	G	Fa
BAX /xc1x	Banks	Ft	G	G	G	Fa
BAX /xc2x	Banks	Ft	G	G	G	Fa
BAX /xc3x	Banks	Ft	G	G	G	Fap
BHY	Bethany	Fws	Fws	Fws	Fsw	Fw
BKO	Breckon	Vwi	Vwi	Vwi	Psw	Viw
BWG	Blue Wing	Fsm	Fsm	G	G	G
BWG /xcxx	Blue Wing	Fsm	Fsm	G	G	G
BWG /xexx	Blue Wing	Vt	Ftm	Fst	G	Ft
BWG /2exx	Blue Wing	Vt	Ftm	Fst	G	Ft
BWG /3exx	Blue Wing	Vt	Ftm	Fst	G	Ft
BYH	Baynham	Vsw	Vsw	Vsw	Vsw	Vaw
CAY	Cayer	Vsw	Vsw	Vsw	Vsw	Vaw
DKS	Dickson	Fws	Fws	Fws	Fw	Fw
DVD	Davidson	Fsm	Fsm	Fs	G	G
DVD /xcxx	Davidson	Fsm	Fms	Fs	G	G
DVD /xc1x	Davidson	Fst	Fsm	Fs	G	G
DVD /xdxx	Davidson	Pt	Fms	Fs	G	G
DVD /xd1x	Davidson	Pt	Fms	Fs	G	G
DVD /xexx	Davidson	Vt	Ftm	Fs	G	Ft
DVD /xfxx	Davidson	Vt	Ptm	Pts	G	Pt
DVD /1cxx	Davidson	Fsm	Fms	Fs	G	G
DVD /1fxx	Davidson	Vt	Ptm	Fts	G	Pt
DVD /1f1x	Davidson	Vt	Ptm	Pts	G	Pt
DVD /2fxx	Davidson	Vt	Ptm	Pt	G	Pt
DVD /3dxx	Davidson	Pt	Fsm	Fs	G	G
ECK	Erickson	Fs	Fs	Fs	Fs	Fa
ECK /xcxx	Erickson	Fst	Fs	Fs	Fs	Fa
ECK /xc1x	Erickson	Fst	Fs	Fs	Fs	Fa
ECK /xc2x	Erickson	Fst	Fs	Fsp	Fs	Fa
ECK /xc3x	Erickson	Fst	Fsp	Pp	Fs	Fap
ECK /xdxx	Erickson	Pt	Fs	Fs	Fs	Fa
ECK /xd1x	Erickson	Pt	Fs	Fs	Fs	Fa
ECK /xd2x	Erickson	Pt	Fs	Fsp	Fs	Fa
ECK /xd3x	Erickson	Ptp	Pp	Pp	Fsp	Fp
ECK /xexx	Erickson	Vt	Ft	Ft	Fs	Fat
ECK /xe3x	Erickson	Vt	Ftp	Ppb	Fsp	Fat
ECK /xf1x	Erickson	Vtp	Pt	Pt	Fts	Pta
ECK /xf2x	Erickson	Vt	Pt	Pt	Ft	Pt
ECK /1cxx	Erickson	Fst	Fs	Fs	Fs	Fa

TABLE. 24 SUITABILITY RATINGS OF SOILS FOR RECREATIONAL USES

Map Symbol and Phase	Soil Name	Play Ground	Picnic Area	Camp Area	Path And Trails	Permanent Bldgs. Without Basements
ECK /1c2x	Erickson	Ftp	Fs	Fsp	Fs	Fa
ECK /1dxx	Erickson	Pt	Fs	Fs	Fs	Fa
ECK /1d1x	Erickson	Pt	Fs	Fs	Fs	Fa
ECK /1d2x	Erickson	Ptp	Fp	Fsp	Fs	Fa
ECK /1exx	Erickson	Vt	Ft	Fts	Fs	Fat
ECK /1e1x	Erickson	Vt	Ft	Fts	Fs	Fat
ECK /1e3x	Erickson	Vtp	Ftp	Ppt	Fps	Fat
ECK /2dxx	Erickson	Pt	Fs	Fs	Fs	Fa
ECK /2d1x	Erickson	Pt	Fs	Fs	Fs	Fa
ECK /2d2x	Erickson	Ptp	Fps	Fps	Fs	Fa
ECK /2e1x	Erickson	Vt	Fts	Fts	Fs	Fat
ECK /2e3x	Erickson	Vtp	Fts	Pp	Fps	Fat
ECK /2fxx	Erickson	Vt	Pt	Pt	Fts	Pta
ECK /2f1x	Erickson	Vt	Pt	Pt	Fts	Pta
ECK /3d2x	Erickson	Ptp	Fsp	Fp	Fs	Fa
ECK /3d4x	Erickson	Ppt	Pps	Pp	Pps	Fpa
ECK /3e2x	Erickson	Vtp	Fts	Ftp	Fs	Fat
ECK /3f1x	Erickson	Ptk	Pts	Pt	Ft	Pta
HEC	Heron Creek	Vws	Pw	Psw	Pw	Pwi
HECp	Heron Creek	Vws	Pw	Psw	Pw	Pwi
HRD	Horod	Fsw	Fsw	Fsw	Fsw	Fw
KHI	Katherine	Fws	Fws	Fws	Fsw	Fw
KHI /xcxx	Katherine	Fws	Fws	Fws	Fsw	Fw
KHI /xc3x	Katherine	Fwp	Fwp	Fwp	Fsp	Fw
KIC	Kircro	Vsw	Vsw	Vsw	Vsw	Vaw
LSW	Lenswood	Fws	Fws	Fws	Fw	Fw
LSW /xcxx	Lenswood	Fws	Fws	Fws	Fsw	Fw
MWK	Meadowbrook	Fs	Ps	Fs	Fs	Pa
MWK /xcxx	Meadowbrook	Fst	Fs	Fs	Fs	Pa
OKO	Okno	Vws	Vws	Vws	Vws	Va
OOL	Onanole	Fs	Fs	Fs	Fs	Fa
OOL /xcxx	Onanole	Fst	Fs	Fs	Fs	Fa
OOL /xdxx	Onanole	Pt	Fs	Fs	Fs	Fa
OOL /1dxx	Onanole	Pt	Fs	Fs	Fs	Fa
OOL /2dxx	Onanole	Pt	Fs	Fs	Fs	Fa
OOL /2exx	Onanole	Vt	Fst	Fst	Fs	Ft
OZA	Ozerna	Fs	Fs	Fs	G	G
OZA /xcxx	Ozerna	Pts	Fs	Fs	G	G
OZA /xc2x	Ozerna	Fst	Fs	Fsp	G	G
OZA /xdxx	Ozerna	Pt	Fs	Fs	G	G

TABLE. 24 SUITABILITY RATINGS OF SOILS FOR RECREATIONAL USES

Map Symbol and Phase		Soil Name	Play Ground	Picnic Area	Camp Area	Path And Trails	Permanent Bldgs. Without Basements
OZA	/xexx	Ozerna	Vts	Fts	Fts	G	Ft
PPL		Poppleton	Fsw	Fsw	Fsw	Fw	Pw
PPL	/xcxx	Poppleton	Fwm	Fs	Fws	Fw	Fw
PPL	/xfxx	Poppleton	Fwt	Pts	Ftw	Fk	Pt
PTU		Petlura	Fws	Pw	Fws	Fws	Fwa
PTU	/xcxx	Petlura	Fws	Pw	Fws	Fws	Fwa
PTU	/xc1x	Petlura	Fst	Pw	Fws	Fws	Fwa
PVK		Proven Lake	Vw	Vw	Vwi	Pw	Pwf
PVKp		Proven Lake	Vw	Vw	Vws	Vsw	Viw
PVK	/xxxs	Proven Lake	Vw	Vwi	Vwi	Pw	Pwf
RBN		Roblin	Vw	Vw	Vw	Pw	Vh
RKH		Rackham	Fs	Fs	Fs	Fs	Fa
RKH	/xdxx	Rackham	Pt	Fs	Fs	Fs	Fa
RKH	/2exx	Rackham	Vt	Fst	Fst	Fs	Fat
RTV		Rat River	Vsw	Vsw	Vsw	Vsw	Vaw
SHH		Seech	Pm	Fsm	Fs	Fc	G
SHH	/xx2x	Seech	Pm	Fsm	Fs	Fc	G
SHH	/xcxx	Seech	Pm	Fsm	Fs	Fc	G
SHH	/xc1x	Seech	Pm	Fsm	Fs	Fc	G
SHH	/xc3x	Seech	Pm	Fsm	Pp	Fpc	G
SHH	/xdxx	Seech	Ptm	Fsm	Fs	Fc	G
SHH	/xd3x	Seech	Ptm	Fsm	Pp	Fpc	G
SHH	/xexx	Seech	Vt	Fst	Fst	Fc	Ft
SHH	/xfxx	Seech	Vt	Fst	Pt	Ftc	Ft
SHH	/1e1x	Seech	Vt	Fst	Fst	Fc	Ft
SHH	/1e2x	Seech	Vt	Fst	Fst	Fc	Ft
SHH	/1e3x	Seech	Vt	Fst	Fst	Fpc	Ftp
SHH	/1fxx	Seech	Vt	Fst	Pt	Ftc	Pt
SHH	/2e2x	Seech	Vt	Fst	Fst	Fc	Ft
SHHc		Seech	Pm	Fs	Fs	Fc	G
SNT		Sinnott	Pw	Vwi	Vwi	Pw	Vwi
SNT	/xx2x	Sinnott	Pw	Vwi	Vwi	Pw	Vwi
SNTp		Sinnott	Vw	Vsw	Vws	Vsw	Viw
STD		Stead	Vsw	Vsw	Vsw	Vsw	Vaw
SWF		Swanford	Fw	Fw	Fw	Fw	Fw
SWN		Swan	Fws	Fws	Pw	Fws	Fwa
SWN	/xcxx	Swan	Fst	Fws	Pw	Fws	Fwa
TEK		Tee Lake	Fws	Fws	Fws	Fsw	Fwf
TEK	/xc3x	Tee Lake	Fws	Fws	Fws	Fsw	Fwp
TEK	/xx2x	Tee Lake	Fws	Fws	Fws	Fsw	Fwf

TABLE. 24 SUITABILITY RATINGS OF SOILS FOR RECREATIONAL USES

Map Symbol and Phase	Soil Name	Play Ground	Picnic Area	Camp Area	Path And Trails	Permanent Bldgs. Without Basements
VLY	Valley	Fws	Fws	Fws	Fws	Faw
VLY /xcxx	Valley	Fws	Fws	Fws	Fsw	Fwf
VST	Vista	Pw	Pw	Pw	Pws	Pwi
VSTp	Vista	Vsw	Vsw	Vs	Vsw	Vaw
WLM	Wellman	Fs	Fs	Ps	Fs	Pas
WTV	Waitville	Fs	Fs	Fs	Fs	Fa
WTV /xx3x	Waitville	Pp	Fsp	Pp	Fsp	Fap
WTV /xcxx	Waitville	Fst	Fs	Fs	Fs	Fa
WTV /xc1x	Waitville	Fst	Fs	Fs	Fs	Fa
WTV /xc2x	Waitville	Fst	Fs	Fs	Fs	Fa
WTV /xc3x	Waitville	Fst	Fsp	Pps	Fsp	Fap
WTV /xdxx	Waitville	Pt	Fs	Fs	Fs	Fa
WTV /xd1x	Waitville	Pt	Fs	Fs	Fs	Fa
WTV /xd2x	Waitville	Pt	Fs	Fsp	Fs	Fa
WTV /xexx	Waitville	Vt	Fst	Fst	Fs	Fat
WTV /xe1x	Waitville	Vt	Fst	Fst	Fs	Fat
WTV /xe2x	Waitville	Vt	Fst	Fst	Fs	Fat
WTV /xe3x	Waitville	Vt	Ftp	Ppt	Fsp	Fat
WTV /xfxx	Waitville	Vt	Pt	Pt	Fst	Pt
WTV /xf1x	Waitville	Vt	Pts	Pt	Fst	Pt
WTV /xf3x	Waitville	Vt	Ptp	Ptp	Fpt	Ptp
WTV /xg2x	Waitville	Vt	Vt	Vt	Pt	Vt
WTV /1d2x	Waitville	Pt	Fs	Fsp	Fs	Fa
WTV /1exx	Waitville	Vt	Fst	Fst	Fs	Fta
WTV /1e2x	Waitville	Vt	Fst	Fst	Fs	Fta
WTV /1f1x	Waitville	Vt	Pt	Pt	Fts	Pt
WTV /2c1x	Waitville	Fst	Fs	Fs	Fs	Fa
WTV /2d2x	Waitville	Pt	Fs	Fps	Fs	Fa
WTV /2e1x	Waitville	Pt	Fst	Fst	Fs	Fat
WTV /2e2x	Waitville	Vt	Fst	Fst	Fs	Fat
WTV /2e3x	Waitville	Vt	Ftp	Pp	Fps	Fat
WTV /2f1x	Waitville	Vt	Pts	Vt	Fts	Pt
WTV /2f2x	Waitville	Vt	Pts	Vtp	Fts	Pt
ZAP	Zaporosa	Pm	Fsm	Fs	Fc	G
ZAP /xd1x	Zaporosa	Ptm	Fsm	Fs	Fc	G
ZAP /xd2x	Zaporosa	Ptm	Fsm	Fps	Fc	G
ZAP /xexx	Zaporosa	Vtm	Fst	Fst	Fc	Ft
ZAP /xe1x	Zaporosa	Vtm	Fst	Fst	Fc	Ft
ZAP /xe2x	Zaporosa	Vtm	Ftp	Fst	Fc	Ft
ZAP /xe3x	Zaporosa	Vtm	Fst	Ppt	Fpc	Ftp

TABLE. 24 SUITABILITY RATINGS OF SOILS FOR RECREATIONAL USES

Map Symbol and Phase	Soil Name	Play Ground	Picnic Area	Camp Area	Path And Trails	Permanent Bldgs. Without Basements
ZAP /xf2x	Zaporosa	Vtm	Pts	Ptp	Ftc	Pt
ZAP /1dxx	Zaporosa	Ptm	Fsm	Fs	Fc	G
ZAP /1d2x	Zaporosa	Ptm	Fsm	Fp	Fc	G
ZAP /2d2x	Zaporosa	Ptm	Fsm	Fp	Fc	G
ZAP /2exx	Zaporosa	Vtm	Fst	Fts	Fc	Ft
ZAP /3e1x	Zaporosa	Vtm	Fst	Fts	Fc	Fat
ZAP /3e2x	Zaporosa	Vtm	Fst	Fts	Fc	Ft
ZAP /3f1x	Zaporosa	Vtm	Pts	Fts	Fc	Pt

Appendix A

GLOSSARY

AASHO classification (soil engineering) - The official classification of soil materials and soil aggregate mixtures for highway construction used by the American Association of State Highway Officials.

Acid soil - A soil having a pH less than 7. See pH and Reaction, soil.

Alkaline soil - A soil having a pH greater than 7. See Reaction, soil.

Alluvium - A general term for all deposits of rivers and streams.

Arable soil - Soil suitable for plowing and cultivation.

Association - A sequence of soils of about the same age, derived from similar parent material, and occuring under similar climatic conditions but showing different characteristics due to variations in relief and in drainage.

1/3 Atmosphere Moisture - The moisture percentage on dry weight basis of a soil sample that has been air dried, screened, saturated and subjected to a soil moisture tension of 345 cm of water through a permeable membrane for a period of 48 hours. It approximates the soil moisture retention capacity.

Available nutrient - That portion of any element or compound in the soil that can be readily absorbed and assimilated by growing plants.

Available soil moisture - The portion of water in a soil that can be readily absorbed by plant roots: generally considered to be that water held in the soil up to approximately 15 atmospheres pressure.

Bearing capacity - Capacity of soil (in moist to wet conditions) to support loads such as buildings, people, vehicles, and animals.

Bedrock - The solid rock that underlies soil and regolith or that is exposed at the surface.

Boulders - Stones which are larger than 60 cm in diameter.

Bulk density - The weight of oven dry soil (105 degrees C) divided by its volume at field moisture conditions, expressed in grams per cubic centimeter.

Buried soil - Soil covered by an alluvial, loessial, or other deposit, usually to a depth greater than the thickness of the solum.

Calcareous soil - Soil containing sufficient calcium carbonate (often with magnesium carbonate) to effervesce visibly when treated with hydrochloric acid.

Calcium Carbonate Equivalent - Refers to the percent of carbonates in

the soil expressed on the basis of calcium carbonate. Terms used to express the carbonate contents of soils are:

noncalcareous	<1%
weakly calcareous	1-5%
moderately calcareous	6-15%
strongly calcareous	16-25%
v. strongly calcareous	26-40%
extremely calcareous	>40%

Capillary fringe - A zone of essentially saturated soil just above the water table. The size distribution of the pores determines the extent and degree of the capillary fringe.

Carbon-nitrogen ratio (C/N ratio) - The ratio of the weight of organic carbon to the weight of total nitrogen in a soil or in an organic material.

Cation Exchange Capacity (CEC) - A measure of the total amount of exchangeable cations that can be held by a soil. Expressed in milliequivalents per 100g of soil.

Clay - As a soil separate, the mineral soil particles less than 0.002 mm in diameter: usually consisting largely of clay minerals. As a soil textural class, soil materials that contain 40 or more percent clay, less than 45 percent sand and less than 40 percent silt.

Cobbles - Rock fragments 8 to 25 cm in diameter.

Color - Soil colors are compared with a Munsell color chart. The Munsell system specifies the relative degrees of the three simple variables of color: hue, value and chroma. For example: 10YR 6/4 means a hue of 10YR, a value of 6, and a chroma of 4.

Complex (soil) - A mapping unit used in detailed and reconnaissance soil surveys where two or more soil series that are so intimately intermixed in an area that it is impractical to separate them at the scale of mapping used.

Concretions - Hard grains, pellets or nodules from concentration of compounds in the soil that cement soil grains together.

Conductivity, electrical - A physical quantity that measures the readiness with which a medium (irrigation water and soil extracts) transmits electricity. It expresses the concentration of salt in terms of the conductance (reciprocal of the electric resistance in ohms) in milliSiemens per cm (or expressed as deciSiemens per meter - dS/m).

Consistence (soil) - The mutual attraction of the particles in a soil mass, or their resistence to separation or deformation. It is described in terms such as loose, soft, friable, firm, hard, sticky, plastic or cemented.

Consumptive use factor (CU) - The ratio of consumptive use of water by a crop to potential evapotranspiration. and transpiration. An actively growing crop that completely covers the soil over a large area and that has an ample supply of readily available soil water has a consumptive use factor of 1.0.

Consumptive use of water - The sum of the depths of water transpired by the plants and evaporated from the soil surface and from intercepted precipitation. It may be less or greater than potential evapotranspiration.

Contour - An imaginary line connecting points of equal elevation on the surface of the soil.

Cover - This term generally has one of the following meanings:

1. Vegetation or other material providing protection

2. In forestry, low growing shrubs and herbaceous plants under trees (i.e., ground cover vs. tree cover)

3. Any vegetation producing a protective mat on or just above the soil surface.

Creep (soil) - Slow mass movement of soil and soil material down rather steep slopes primarily under the influence of gravity, but aided by saturation with water and by alternate freezing and thawing.

Decile portion - A one-tenth portion. As used in the soil map symbol A7-B3 means that the A soils cover seven tenths and the B soils cover three tenths of the map unit.

Delta - A fluvial or glaciofluvial fan shaped deposit at the mouth of a river that empties into a lake or sea.

Deflocculate - To separate or to break up soil aggregates into individual particles by chemical or physical means or both.

Degradation (of soils) - The changing of a soil to a more highly leached and more highly weathered condition, usually accompanied by morphological changes such as the development of an eluviated light colored (Ae) horizon.

Dispersion - Is rated high, moderate or low depending on how readily the soil structure breaks down or slakes because of excess moisture. A rating of high indicates that soil aggregates slake readily; a rating of low indicates that aggregates are resistant to dispersion and remain clumped together.

Drainage (soil) - (1) The rapidity and extent of the removal of water from the soil by runoff and flow through the soil to underground spaces. (2) As a condition of the soil, it refers to the frequency and duration of periods when the soil is free of saturation.

Drainage in soil reports is described on the basis of actual moisture content in excess of field capacity and length of the saturation period within the plant root zone. The terms are as follows:

Very rapidly drained - Water is removed from the soil very rapidly in relation to supply. Excess water flows downward very rapidly if underlying material is pervious. There may be very rapid subsurface flow during heavy rainfall provided there is a steep gradient. Soils have very low available water storage capacity (usually less than 2.5 cm) within the control section and are usually coarse in texture, or shallow, or both. Water source is precipitation.

Rapidly drained - Water is removed from the soil rapidly in relation to supply. Excess water flows downward if underlying material is pervious. Subsurface flow may occur on steep gradients during heavy rainfall. Soils have low available water storage capacity (2.5-4 cm) within the

control section, and are usually coarse in texture, or shallow, or both. Water source is precipitation.

Well drained - Water is removed from the soil readily but not rapidly. Excess water flows downward readily into underlying pervious material or laterally as subsurface flow. Soils have intermediate available water storage capacity (4-5 cm) within the control section, and are generally intermediate in texture and depth. Water source is precipitation. On slopes subsurface flow may occur for short durations but additions are equaled by losses. These soils are usually free of mottles within 100 cm of the surface but may be mottled below this depth. Soil horizons are usually bright colored.

Moderately well drained - Water is removed from the soil somewhat slowly in relation to supply. Excess water is removed somewhat slowly due to low perviousness, shallow water table, lack of gradient, or some combination of these. Soils have intermediate to high water storage capacity (5-6cm) within the control section and are usually medium to fine in texture. Soils are commonly mottled in the 50 to 100 cm depth. Colors are dull brown in the subsoil with stains and mottles.

Imperfectly drained - Water is removed from the soil sufficiently slowly in relation to supply to keep the soil wet for a significant part of the growing season. Excess water moves slowly downward if precipitation is major supply. If subsurface water or groundwater, or both, is the main source, flow rate may vary but the soil remains wet for a significant part of the growing season. Precipitation is the main source if available water storage capacity is high; contribution by subsurface flow or groundwater flow, or both, increases as available water storage capacity decreases. Soils have a wide range in available water supply, texture, and depth, and are gleyed phases of well drained subgroups. These soils generally have mottling below the surface layers and generally have duller colors with depth, generally brownish gray with mottles of yellow and gray.

Poorly drained - Water is removed so slowly in relation to supply that the soil remains wet for a comparatively large part of the time the soil is not frozen. Excess water is evident in the soil for a large part of the time. Subsurface flow or groundwater flow, or both, in addition to precipitation are main water sources; there may also be a perched water table, with precipitation exceeding evapotranspiration. Poorly drained soils have a wide range in available water storage capacity, texture, and depth, and are gleyed subgroups, Gleysols, and Organic soils.

Very poorly drained - Water is removed from the soil so slowly that the water table remains at or on the surface for the greater part of the time the soil is not frozen. Excess water is present in the soil for the greater part of the time. Groundwater flow and subsurface flow are major water sources. Precipitation is less important except where there is a perched water table with precipitation exceeding evapotranspiration. These soils have a wide range in available water

storage capacity, texture, and depth, and are either Gleysolic or Organic.

Dryland farming - The practice of crop production in low rainfall areas without irrigation.

Eluvial horizon - A horizon from which material has been removed in solution or in water suspension.

Eolian - Soil material accumulated through wind action.

Erosion - The wearing away of the land surface by detachment and transport of soil and rock material through the action of moving water, wind or other geological processes. The ratings of erosion are:

Erosion 1 slightly eroded - soil with a sufficient amount of the A horizon removed that ordinary tillage will bring up and mix the B horizon or other lower lying horizons with surface soil in the plow layer.

Erosion 2 moderately eroded - soil with all of the A horizon and a part of the B or other lower lying horizons removed. The plow layer consists mainly of the original horizons below the A or below the original plow layer.

Erosion 3 severely eroded - soils have practically all of the original surface soil removed. The plow layer consists mainly of C horizon material, especially on knolls and steep upper slope positions.

Evapotranspiration - The combined loss of water from a given area, and during a specific period of time, by evaporation from the soil surface and transpiration from plants.

Field Moisture Equivalent - The minimum moisture content at which a drop of water placed on a smoothed surface of the soil will not be absorbed immediately by the soil, but will spread out over the surface and give it a shiny appearance.

Flood plain - The land bordering a stream, built up of sediments from overflow of the stream and subject to inundation when the stream is at flood stage.

Fluvial deposits - All sediments past and present, deposited by flowing water, including glaciofluvial deposits.

Frost heave - The raising of the surface caused by ice in the subsoil.

Friable - Soil aggregates that are soft and easily crushed between thumb and forefinger.

Glaciofluvial deposits - Material moved by glaciers and subsequently sorted and deposited by streams flowing from the melting ice. These deposits are stratified and may occur in the form of outwash plains, deltas, kames, eskers and kame terraces.

Gleyed soil - An imperfectly or poorly drained soil in which the material has been modified by reduction or alternating reduction and oxidation. These soils have

lower chromas or more prominent mottling or both in some horizons than the associated well-drained soil.

Gleysolic - An order of soils developed under wet conditions and permanent or periodic reduction. These soils have low chromas or prominent mottling or both, in some horizons.

Gravel - Rock fragments 2 mm to 7.5 cm in diameter.

Ground Moraine - An unsorted mixture of rocks, boulders, sand, silt and clay deposited by glacial ice. The predominant material is till; most till is thought to have accumulated under the ice by lodgment, but some till has been let down from the upper surface of the ice by ablation. Resorting and modification may have taken place to some extent by wave-action of glacial melt waters. The topography is most commonly in the form of undulating plains with gently sloping hills and enclosed depressions.

Groundwater - Water beneath the soil surface, usually under conditions where the voids are completely filled with water (saturation).

Halophytic vegetation - vegetation that grows naturally in soils having a high content of various salts. It usually has fleshy leaves or thorns and resembles desert vegetation.

Horizon (soil) - A layer in the soil profile approximately parallel to the land surface with more or less well-defined characteristics that have been produced through the operation of soil forming processes.

Horizon boundary - The lower boundary of each horizon is described by indicating its distinctness and form. The distinctness depends on the abruptness of vertical change (thickness). The form refers to the variation of the boundary plane.

Distinctness -
abrupt - less than 2 cm
clear - 2 to 5 cm
gradual - 5 to 15 cm
diffuse - more than 15 cm

Form -
smooth - nearly plain
wavy - pockets are wider than deep
irregular - pockets are deeper than wide
broken - parts of the horizon are unconnected with other parts

Humic layer - A layer of highly decomposed organic soil material containing little fibre.

Hydraulic Conductivity - Refers to the effective flow velocity or discharge velocity in soil at unit hydraulic gradient. It is an approximation of the permeability of the soil and is expressed in cm per hour. The classes are described in general or specific terms as:

High	>15	Very rapid	>50
		Rapid	15-50
Medium	0.5-15	Mod. rapid	5.0-15
		Moderate	1.5-5.0
		Mod. slow	0.5-1.5
Low	<0.5	Slow	0.15-0.5
		Very slow	0.015-0.15
		Extremely slow	<.015

Hydrologic cycle - The conditions through which water naturally passes from the time of precipitation until it is returned to

the atmosphere by evaporation and is again ready to be precipitated.

Hydrophyte - Plants growing in water or dependent upon wet or saturated soil conditions for growth.

Illuvial horizon - A soil horizon in which material carried from an overlying layer has been precipitated from solution or deposited from suspension. The layer of accumulation.

Impeded drainage - A condition that hinders the movement of water by gravity through the soils.

Inclusion - Soil type found within a mapping unit that is not extensive enough to be mapped separately or as part of a complex.

Infiltration - The downward entry of water into the soil

Irrigation - The artificial application of water to the soil for the benefit of growing crops.

Irrigation requirement (IR) - Refers to the amount of water exclusive of effective precipitation that is required for crop production.

Lacustrine deposits - Material deposited by or settled out of lake waters and exposed by lowering of the water levels or elevation of the land. These sediments range in texture from sand to clay and are usually varved (layered annual deposits).

Landforms - See Description of Landforms

Landscape - All the natural features such as fields, hills, forest, water, etc., which distinguish one part of the earth's surface from another part.

Leaching - The removal from the soil of materials in solution.

Liquid limit (upper plastic limit) - The water content corresponding to an arbitrary limit between the liquid and plastic states of consistency of a soil. The water content at this boundary is defined as that at which a pat of soil cut by a groove of standard dimensions will flow together for a distance of 1.25 cm under the impact of 25 blows in a standard liquid limit apparatus.

Lineal shrinkage - This is the decrease in one dimension expressed as a percentage of the original dimension of the soil mass when the moisture content is reduced from a stipulated percentage (usually field moisture equivalent) to the shrinkage limit.

Mapping Unit - Any delineated area shown on a soil map that is identified by a symbol. A mapping unit may be a soil unit, a miscellaneous land type, or a soil complex.

Marsh - Periodically flooded or continually wet areas having the surface not deeply submerged. It is covered dominantly with sedges, cattails, rushes or other hydrophytic plants.

Mature soil - A soil having well-developed soil horizons produced by the natural processes of soil formation.

Mesophyte - Plants requiring intermediate moisture conditions and are not very resistant to drought.

Microrelief - Small-scale, local differences in relief including mounds, swales or hollows.

Milliequivalent (me) - One-thousandth of an equivalent. An equivalent is the weight in grams of an ion or compound that combines with or replaces one gram of hydrogen. The atomic or formula weight divided by valence.

Mottles - Irregularly marked spots or streaks, usually yellow or orange but sometimes blue. They are described in order of abundance (few, common, many), size (fine, medium, coarse) and contrast (faint, distinct, prominent). Mottles in soils indicate poor aeration and lack of good drainage.

Organic carbon - Carbon derived from plant and animal residues.

Organic matter - The fraction of the soil which consists of plant and animal residues at various stages of decomposition, cells and tissues of soil organisms and substances synthesized by the soil population. It is determined on soils that have been sieved through a 2.0 mm sieve. It is estimated by multiplying the organic carbon by a factor of 1.72.

Outwash - Sediments "washed out" beyond the glacier by flowing water and laid down in thin beds or strata. Particle size may range from boulders to silt.

Ovendry soil - Soil that has been dried at 105 degrees C until it has reached constant weight.

Parent material - The unaltered or essentially unaltered mineral or organic material from which the soil profile develops by pedogenic processes.

Particle size, soil - The grain size distribution of the whole soil including the coarse fraction. It differs from texture, which refers to the fine earth (less than 2mm) fraction only. In addition, textural classes are usually assigned to specific horizons whereas soil family particle-size classes indicate a composite particle size of a part of the control section that may include several horizons. See Textural Triangle at end of Glossary.

The particle-size classes for family groupings are as follows:

Fragmental Stones, cobbles and gravel, with too little fine earth to fill interstices larger than 1 mm.

Sandy-skeletal Particles coarser than 2 mm occupy 35% or more by volume with enough fine earth to fill interstices larger than 1 mm; the fraction finer than 2 mm is that defined for the sandy particle-size class.

Loamy-skeletal Particles 2 mm-25 cm occupy 35% or more by volume with enough fine earth to fill interstices larger than 1 mm; the fraction finer than 2 mm is that defined for the loamy particle-size class.

Clayey-skeletal Particles 2 mm-25 cm occupy 35% or more by volume with enough fine earth to fill interstices larger than 1 mm; the fraction finer than 2 mm is that defined for the clayey particle-size class.

Sandy The texture of the fine earth includes sands and loamy sands, exclusive of loamy very fine sand and very fine sand textures; particles 2 mm- 25 cm occupy less than 35% by volume.

Loamy The texture of the fine earth includes loamy very fine sand, very fine sand, and finer textures with less than 35% clay; particles 2 mm-25 cm occupy less than 35% by volume.

Coarse-loamy. A loamy particle size that has 15% or more by weight of fine sand (0.25-0.1 mm) or coarser particles, including fragments up to 7.5 cm, and has less than 18% clay in the fine earth fraction.

Fine-loamy. A loamy particle size that has 15% or more by weight of fine sand (0.25-0.1 mm) or coarser particles, including fragments up to 7.5 cm, and has 18-35% clay in the fine earth fraction.

Coarse-silty. A loamy particle size that has less than 15% of fine sand (0.25-0.1 mm) or coarser particles, including fragments up to 7.5 cm, and has less than 18% clay in the fine earth fraction.

Fine-silty. A loamy particle size that has less than 15% of fine sand (0.25-0.1 mm) or coarser particles, including fragments up to 7.5 cm, and has 18-35% clay in the fine earth fraction.

Clayey. The fine earth contains 35% or more clay by weight and particles 2mm-25 cm occupy less than 35% by volume.

Fine-clayey. A clayey particle size that has 35-60% clay in the fine earth fraction.

Very-fine-clayey. A clayey particle size that has 60% or more clay in the fine earth fraction.

Ped - An individual soil aggregate such as granule, prism or block formed by natural processes (in contrast with a clod which is formed artificially).

Pedology - Those aspects of soil science involving constitution, distribution, genesis and classification of soils.

Percolation - The downward movement of water through soil; specifically, the downward flow of water in saturated or nearly saturated soil at hydraulic gradients of 1.0 or less.

Permafrost -

1. Perennially frozen material underlying the solum.

2. A perennially frozen soil horizon.

Permafrost table - The upper boundary of permafrost, usually coincident with the lower limit of seasonal thaw (active layer).

Permeability - The ease with which water and air pass through the soil to all parts of the profile. See hydraulic conductivity.

pH - The intensity of acidity and alkalinity, expressed as the negative logarithm of the hydrogen ion concentration. A pH of 7 is neutral, lower values indicate acidity and higher values alkalinity (see Reaction, soil).

Phase, soil - A soil phase is used to characterize soil and landscape properties that are not used as criteria in soil taxonomy. The major phase differentiae are: slope, erosion, deposition, stoniness, texture, salinity, and calcareousness.

Plastic Limit - The water content corresponding to an arbitrary limit between the plastic and the semisolid states of consistency of a soil.

Plasticity Index - The numerical difference between the liquid and the plastic limit. The plasticity index gives the range of moisture contents within which a soil exhibits plastic properties.

Potential evapotranspiration (PE) - The maximum quantity of water capable of being lost as water vapor, in a given climate, by a continuous stretch of vegetation covering the whole ground and well supplied with water.

Profile, soil - A vertical section of the soil through all its horizons and extending into the parent material.

Reaction, soil - The acidity or alkalinity of a soil. Soil reaction classes are characterized as follows:

extremely acid	pH <4.5
very strongly acid	4.5 to 5.0
strongly acid	5.1 to 5.5
medium acid	5.6 to 6.0
slightly acid	6.1 to 6.5
neutral	6.6 to 7.3
mildly alkaline	7.4 to 7.8
mod. alkaline	7.9 to 8.4
strongly alkaline	8.5 to 9.0
very strongly alkaline	>9.0

Regolith - The unconsolidated mantle of weathered rock and soil material on the earth's surface.

Relief - The elevation of inequalities of the land surface when considered collectively.

Runoff - The portion of the total precipitation on an area that flows away through stream channels. Surface runoff does not enter the soil. Groundwater runoff or seepage flow from groundwater enters the soil before reaching the stream.

Saline Soil - A nonalkali soil containing soluble salts in such quantities that they interfere with the growth of most crop plants. The conductivity of the saturation extract is greater than 4 millisiemens/cm (ms/cm), the exchangeable-sodium percentage is less than 15, and the pH is usually less than 8.5. Approximate limits of salinity classes are:

non-saline	0 to 4 ms/cm
weakly saline	4 to 8 mS/cm
mod. saline	8 to 15 ms/cm
strongly saline	>15 ms/cm

Salinization - The process of accumulation of salts in the soil.

Salt-Affected Soil - Soil that has been adversely modified for the growth of most crop plants by the presence of certain types of exchangeable ions or of soluble salts. It includes soils having an excess of salts, or an excess of exchangeable sodium or both.

Sand - A soil particle between 0.05 and 2.0 mm in diameter. The textural class name for any soil containing 85 percent or more of sand and not more than 10 percent of clay.

Saturation Percentage - The moisture percentage of a saturated soil paste, expressed on an oven dry weight basis.

Seepage -

1. The escape of water downward through the soil.

2. The emergence of water from the soil along an extensive line of surface in contrast to a spring where water emerges from a local spot.

Series, soil - A category in the Canadian System of Soil Classification. It consists of soils that have soil horizons similar in their differentiating characteristics and arrangement in the profile, except for surface texture and are formed from a particular type of parent material.

Shrinkage limit - This is the moisture content at which an equilibrium condition of volume change is reached and further reduction in moisture content will not cause a decrease in the volume of the soil mass.

Shrinkage ratio - This is the ratio between the volume change and a corresponding change in moisture content. It equals the apparent specific gravity of the dried soil.

Silt - (a) Individual mineral particles of soil that range in diameter between 0.05 to .002 mm. (b) Soil of the textural class silt contains greater than 80 percent silt and less than 12 percent clay.

Slickenside - Smoothed surfaces along planes of weakness resulting from the movement of one mass of soil against another in soils dominated by swelling clays.

Sodium-Adsorption Ratio (S.A.R.) - A ratio for soil extracts and irrigation waters used to express the relative activity of sodium ions in exchange reactions with other cations in the soil SAR = $Na/((Ca+Mg)/2)^{1/2}$ where the cation concentrations are expressed as milliequivalents per litre.

Soil - The unconsolidated mineral material on the immediate surface of the earth that serves as a natural medium for the growth of land plants. Soil has been subjected to and influenced by genetic and environmental factors of: parent material, climate (including moisture and temperature effects), macro- and micro-organisms, and topography, all acting over a period of time.

Solum - The upper horizons of a soil above the parent material and in which the processes of soil formation are active. It usually comprises the A and B horizons.

Stones - Rock fragments greater than 25 cm in diameter.

Stoniness - The percentage of land surface occupied by stones. The classes of stoniness are defined as follows:

Stones 0. Nonstony -- Land having less than 0.01% of surface occupied by stones.

Stones 1. Slightly stony -- Land having 0.01-0.1% of surface occupied by stones. Stones 15-30 cm in diameter, 10-30 m apart. The stones offer only slight to no hindrance to cultivation.

Stones 2. Moderately stony -- Land having 0.1-3% of surface occupied by stones. Stones 15-30 cm in diameter, 2-10 m apart. Stones cause some interference with cultivation.

Stones 3. Very stony -- Land having 3-15% of surface occupied by stones. Stones 15-30 cm in diameter, 1-2 m apart. There are sufficient stones to constitute a serious handicap to cultivation.

Stones 4. Exceedingly stony -- Land having 15-50% of surface occupied by stones. Stones 15-30 cm in diameter, 0.7-1.5 m apart. There are sufficient stones to prevent cultivation until considerable clearing has been done.

Stones 5. Excessively stony -- Land having more than 50% of surface occupied by stones. Stones 15-30 cm in diameter, less than 0.7 m apart. The land is too stony to permit cultivation.

Storage Capacity - Refers to the maximum amount of readily available water that can be stored within the rooting zone of a crop in a given soil. For practical irrigation purposes, 50 percent of the total soil water between field capacity and wilting point may be considered as readily available.

Stratified materials - Unconsolidated sand, silt and clay arranged in strata or layers. In stratified materials, a bed is a unit layer distinctly separable from other layers and is one or more cm thick but a lamina is a similar layer less than 1 cm thick.

Structure - The combination or arrangement of primary soil particles into aggregates of secondary soil particles, units or peds, which are separated from each other by surfaces of weakness. Structure is expressed in terms of grade, size class and shape type. Grade refers to the distinctness of aggregate development, and is described as structureless, weak, moderate or strong. Structureless refers to the absence of observable aggregation of definite orderly arrangement; the term amorphous is used if soil is massive or coherent, single-grained if noncoherent. The weak to strong aggregates vary in size and are described by class as fine, medium, coarse, and very coarse depending on the shape types. The shape types refers to the dominant configuration of the aggregates and the way they are accommodated. The general shape types are plate-like, block-like and prism-like. The terms are:

Platy - Having thin, plate-like aggregates with faces mostly horizontal

Prismatic - Having prism-like aggregates with tops and edges, appear plane, level and somewhat angular.

Columnar - Having prism-like aggregates with vertical edges near the top of columns, not sharp.

Granular - Having block-like aggregates that appear as spheroids or polyhedrons having plane or curved surfaces which have slight or no accommodation to the faces of the surrounding peds.

Blocky - Having block-like aggregates with sharp, angular corners

Subangular blocky - Having block-like aggregates with rounded and flattened faces and rounded corners.

By convention an aggregate is described in the order of grade, class and type, e.g. strong, medium, blocky. In the parent material of soils the material with structural shapes may be designated as pseudo-blocky, pseudo-platy, etc.

Soil Survey - The systematic examination, description, classification, and mapping of soil in an area.

Sulfate Hazard - Refers to the relative degree of attack on concrete by soil and water containing various amounts of sulfate ions. It is estimated from electrolyte measurements and salt analysis on selected profiles and soil samples, and by visual examination of free gypsum within the profile during the course of soil investigation.

Swamp - See Description of Landforms

Texture, soil - The relative proportions of the fine earth (less than 2 mm.) fraction of a soil. Textural classes are usually assigned to specific horizons whereas family particle size classes indicate a composite particle size of a portion of the control section that may include several horizons. See Texture Triangle at end of Glossary.

The size range of the constituent primary particles are as follows:

	Diameter (mm)
Very coarse sand. . . .	.2.0-1.0
Coarse sand	.1.0-0.5
Medium sand	0.5-0.25
Fine sand	.0.25-0.10
Very fine sand. . . .	.0.10-0.05
Silt.	0.05-0.002
Clay.	.< 0.002
Fine clay	< 0.0002

Till, glacial - Unstratified glacial deposits consisting of clay, sand, gravel, and boulders intermingled in any proportion.

Tilth - The physical condition of soil as related to its ease of tillage, fitness as a seedbed, and its impedance to seedling emergency and root penetration.

Topography - Refers to the percent slope and the pattern or frequency of slopes in different directions. A set of 10 slope classes are used to denote the dominant but not necessarily most abundant slopes within a mapping unit.

Slope Class	Slope Name	Percent slope	Approx. degrees
1	level	0-0.5	0
2	nearly level	.5-2.5	.3-1.5
3	very gentle	2-5	1-3
4	gentle	6-9	3.5-5
5	moderate	10-15	6-8.5
6	strong	16-30	9-17
7	very strong	31-45	17-24
8	extreme	46-70	25-35
9	steep	71-100	35-45
10	very steep	>100	>45

Underground runoff - (or seepage)-Water flowing towards stream channels after infiltration into the ground.

Unified Soil Classification System (engineering) - A classification system based on the identification of soils according to their particle size, gradation, plasticity index and liquid limit.

Urban Land - Areas so altered or obstructed by urban works or structures that identification of soils is not feasible.

Variant, soil - A soil whose properties are believed to be sufficiently different from other known soils to justify a new series name, but comprising such a limited geographic area that creation of a new series is not justified.

Varve - A distinct band representing the annual deposit in sedimentary materials regardless of origin and usually consisting of two layers, one thick light colored layer of silt and fine sand laid down in the spring and summer, and the other a thin, dark colored layer of clay laid down in the fall and winter.

Water balance, soil - Is the daily amount of readily available water retained by the soil. The daily soil-water balance is decreased by the amount that the daily consumptive use exceeds the daily rainfall. When daily rainfall exceeds the consumptive use, the daily balance increases by the amount of the difference unless the soil-water balance is at storage capacity, in which case the excess is assumed to be lost by runoff or deep percolation.

Water table - (groundwater surface; free water surface; groundwater elevation) Elevation at which the pressure in the water is zero with respect to the atmospheric pressure.

Water table depths - (cm) -

Generally High	<100
Very High	0-50
Moderately High	50-100
Medium High	100-150
Generally Low	>150
Medium Low	150-200
Low	>200
Moderately Low	200-300
Very Low	>300

Water-holding capacity - The ability of a soil to hold water against the force of gravity in a freely drained soil.

Weathering - The physical and chemical disintegration, alteration and decomposition of rocks and minerals at or near the earth's surface by atmospheric agents.

Xerophyte - Plants capable of surviving extended periods of soil drought.

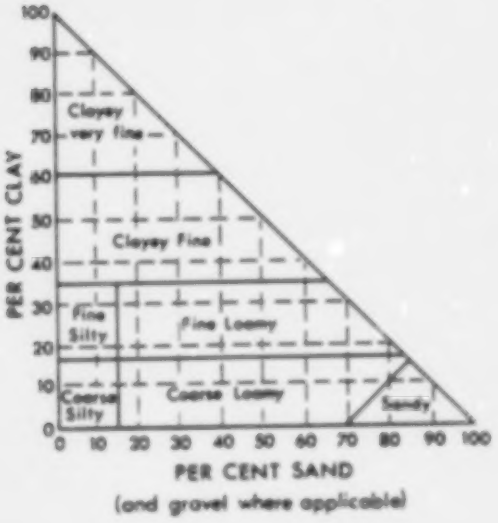
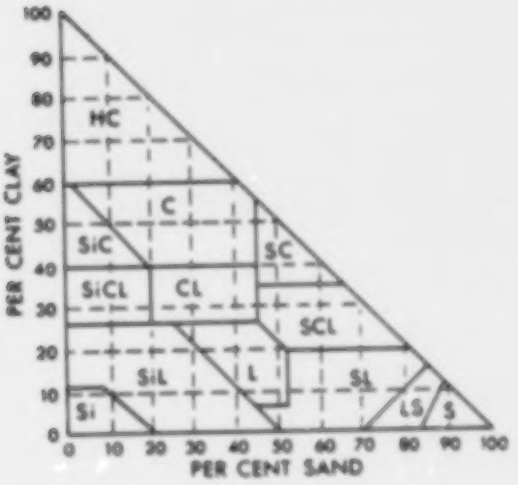


Figure 7: Family particle-size classes.



Texture Group	Class Symbol	Class Name
Coarse	S	sand
	LS	loamy sand
Moderately coarse	SL	sandy loam
	LVFS	loamy very fine sand
Medium	Si	silt
	SiL	silt loam
	L	loam
	VFSL	very fine sandy loam
Moderately fine	SCL	sandy clay loam
	CL	clay loam
	SiCL	silty clay loam
Fine	SC	sandy clay
	C	clay
	SiC	silty clay
Very fine	HC	heavy clay

Figure 8: Soil Textural Classes.

Appendix B

SOIL HORIZON DESIGNATIONS

ORGANIC HORIZONS

Organic horizons are found in Organic soils, and commonly at the surface of mineral soils. They may occur at any depth beneath the surface in buried soils, or overlying geologic deposits. They contain more than 17% organic carbon (approximately 30% organic matter) by weight. Two groups of these horizons are recognized, O horizons and the L, F, and H horizons.

O This is an organic horizon developed mainly from mosses, rushes, and woody materials.

Of The fibric horizon is the least decomposed of all the organic soil materials. It has large amounts of well-preserved fiber that are readily identifiable as to botanical origin. A fibric horizon has 40% or more of rubbed fiber by volume and a pyrophosphate index of 5 or more. If the rubbed fiber volume is 75% or more, the pyrophosphate criterion does not apply.

Om The mesic horizon is the intermediate stage of decomposition with intermediate amounts of fiber, bulk density and water-holding capacity. The material is partly altered both physically and biochemically. A mesic horizon is one that fails to meet the requirements of fibric or humic.

Oh The humic horizon is the most highly decomposed of the organic soil materials. It has the least amount of fiber, the highest bulk density, and the lowest saturated water-holding capacity. It is very stable and changes very little physically or chemically with time unless it is drained. The humic horizon has less than 10% rubbed fiber by volume and a pyrophosphate index of 3 or less.

LFH These organic horizons developed primarily from leaves, twigs, woody materials and a minor component of mosses under imperfectly to well drained forest conditions.

L This is an organic horizon characterized by an accumulation of organic matter in which the original structures are easily discernible.

F This is an organic horizon characterized by an accumulation of partly decomposed organic matter. The original structures in part are difficult to recognize. The horizon may be partly comminuted by soil fauna as in moder, or it may be a partly decomposed mat permeated by fungal hyphae as in mor.

H This is an organic horizon characterized by an accumulation of decomposed organic

matter in which the original structures are indiscernible. This material differs from the F horizon by its greater humification chiefly through the action of organisms. It is frequently intermixed with mineral grains, especially near the junction with the mineral horizon.

MASTER MINERAL HORIZONS

Mineral horizons are those that contain less than 30% organic matter by weight as specified for organic horizons.

A This is a mineral horizon or horizons formed at or near the surface in the zone of leaching or removal of materials in solution and suspension or of maximum in situ accumulation of organic matter, or both. Included are:

1. horizons in which organic matter has accumulated as a result of biological activity (Ah);

2. horizons that have been eluviated of clay, iron, aluminum, or organic matter, or all of them (Ae);

3. horizons having characteristics of 1) and 2) above but transitional to underlying B or C (AB or A and B);

4. horizons markedly disturbed by cultivation or pasture (Ap).

B This is a mineral horizon or horizons characterized by one or more of the following:

1. an enrichment in silicate clay, iron, aluminum, or humus, alone or in combination (Bt,Bf,Bfh,Bhf, and Bh);

2. a prismatic or columnar structure that exhibits pronounced coatings or stainings and significant amount of exchangeable Na (Bn);

3. an alteration by hydrolysis, reduction, or oxidation to give a change in color or structure from horizons above or below, or both, and does not meet the requirements of 1) and 2) above (Bm,Bg).

C This is a mineral horizon or horizons comparatively unaffected by the pedogenic processes operative in A and B, excepting (i) the process of gleying, and (ii) the accumulation of calcium and magnesium carbonates and more soluble salts (Cca,Csa,Cg, and C). Marl and diatomaceous earth are considered to be C horizons.

R This is consolidated bedrock that is too hard to break with the hands or to dig with a spade when moist and that does not meet the requirement of a C horizon. The boundary between the R layer and overlying unconsolidated material is called a lithic contact.

W This is a layer of water in Gleysolic, Organic, or Cryosolic soils. It is called a hydric layer in Organic soils.

LOWER-CASE SUFFIXES

b Buried soil horizon.

c A cemented (irreversible) pedogenic horizon. The ortstein of a Podzol, and a layer cemented by calcium carbonate and a duripan are examples.

ca A horizon with secondary carbonate enrichment where the concentration of lime exceeds that present in the unenriched parent material. It is more than 10 cm thick, and if it has a $CaCO_3$ equivalent of less than 15 percent it should have at least 5 percent more $CaCO_3$ equivalent than the parent material (IC). If it has more than 15 percent $CaCO_3$ equivalent it should have 1/3 more $CaCO_3$ equivalent than the IC. If no IC is present, this horizon is more than 10 cm thick and contains more than 5 percent by volume of secondary carbonates in concretions or soft, powdery forms.

cc Cemented (irreversible) pedogenic concretions.

e A horizon characterized by the eluviation of clay, iron, aluminum, or organic matter alone or in combination. When dry, it is usually higher in color value by 1 or more units than an underlying B horizon. It is used with A (Ae).

f A horizon enriched with amorphous material, principally Al and Fe combined with organic matter. It usually has a hue of 7.5YR or redder or its hue is 10YR near the upper boundary and becomes yellower with depth. When moist, the chroma is higher than 3 or the value is 3 or less. It contains 0.6% or more pyrophosphate-extractable Al+Fe in textures finer than sand and 0.4% or more in sands (coarse sand, sand, fine sand, and very fine sand). The ratio of pyrophosphate-extractable Al+Fe to clay (less than 0.002mm) is more than 0.05 and organic C exceeds 0.5%. Pyrophosphate-extractable Fe is at least 0.3%, or the ratio of organic C to pyrophosphate-extractable Fe is less than 20, or both are true. It is used with B alone (Bf), with B and h (Bhf), with B and g (Bfg), and with other suffixes. The criteria for "f" do not apply to Bgf horizons. The following horizons are differentiated on the basis of organic carbon content: Bf - 0.5% to 5% organic carbon. Bhf-more than 5% organic carbon.

g A horizon characterized by gray colors, or prominent mottling, or both, indicative of permanent or periodic intense reduction. Chromas of the matrix are generally 1 or less. It is used with A and e (Aeg); with B alone (Bg); with B and f (Bfg); with B, h, and f (Bhfg); with B and t (Btg); with C alone (Cg); with C and k (Ckg); and several others. In some reddish parent materials, matrix colors of reddish hues and high chromas may persist despite long periods of reduction. In these soils, horizons are designated as g if there is gray mottling or if there is marked bleaching on ped faces or along cracks.

Aeg This horizon must meet the definitions of A,e, and g.

Bg These horizons are analogous to Bm horizons but they have colors indicative of poor drainage and periodic reduction. They include horizons occurring between A and C horizons in which the main features are (i) colors of low chroma, that is: chromas of 1 or less, without mottles on ped surfaces or in the matrix if peds are lacking; or chromas of 2 or less in hues of 10YR or redder, on ped surfaces or in the matrix if peds are lacking, accompanied by more promi-

nent mottles than those in the C horizon; or hues bluer than 10Y, with or without mottles on ped surfaces or in the matrix if peds are lacking. (ii) colors indicated in (i) and a change in structure from that of the C horizons. (iii) color indicated in (i) and illuviation of clay too slight to meet the requirements of Bt; or accumulation or iron oxide too slight to meet the limits of Bgf. (iv) colors indicated in (i) and removal of carbonates. Bg horizons occur in some Orthic Humic Gleysols and some Orthic Gleysols.

Bfg, Bhfg, Btg, and others. When used in any of these combinations the limits set for f, hf, t, and others must be met.

Bgf The dithionite-extractable Fe of this horizon exceeds that of the IC by 1% or more. Pyrophosphate-extractable Al + Fe is less than the minimum limit specified for 'f' horizons. This horizon occurs in Fera Gleysols and Fera Humic Gleysols, and possibly below the Bfg of gleyed Podzols. It is distinguished from the Bfg of gleyed Podzols on the basis of the extractability of the Fe and Al. The Fe in the Bgf horizon is thought to have accumulated as a result of the oxidation of ferrous iron. The iron oxide formed is not associated intimately with organic matter or with Al, and it is sometimes crystalline. The Bgf horizons are usually prominently mottled, with more than half of the soil material occurring as mottles of high chroma.

Cg, Ckg, Ccag, Csg, Csag. When g is used with C alone, or with C and one of the lower-case suffixes k, ca, s, or sa, it must meet the difinition for C and for the particular suffix.

h A horizon enriched with organic matter. It is used with A alone (Ah); or with A and e (Ahe); or with B alone (Bh); or with B and f (Bhf).

Ah A horizon enriched with organic matter that either has a color value at least one unit lower than the underlying horizon or contains 0.5% more organic carbon than the IC, or both. It contains less than 17% organic carbon by weight.

Ahe An Ah horizon that has undergone eluviation as evidenced, under natural conditions, by streaks and splotches of differing shades of gray and often by platy structure. It may be overlain by a darker-colored Ah and underlain by a lighter-colored Ae.

Bh This horizon contains more than 1% organic carbon, less than 0.3% pyrophosphate-extractable Fe, and has a ratio of organic carbon to pyrophosphate-extractable Fe of 20 or more. Generally the color value and chroma are less than 3 when moist.

Bhf Defined under 'f'.

j Used as a modifier of the suffixes e, f, g, n, and t to denote an expression of, but failure to meet, the specified limits of the suffix it modifies. It must be placed to the right and adjacent to the suffix it modifies. For example Bfgj means a Bf horizon with weak expression of gleying; Bfjgj means a B horizon with weak expression of both 'f' and 'g' features.

Aej It denotes an eluvial horizon that is thin, discontinuous or slightly discernible.

Btj It is a horizon with some illuviation of clay, but not enough to meet the limits of Bt.

Btgj, Bmgj. Horizons that are mottled but do not meet the criteria of Bg.

Bfj It is a horizon with some accumulation of pyrophosphate-extractable Al and Fe but not enough to meet the limits of Bf.

Bntj or Bnj. Horizons in which development of solonetzic B properties is evident but insufficient to meet the limits for Bn or Bnt.

k Denotes the presence of carbonate, as indicated by visible effervescence when dilute HCl is added. Most often it is used with B and m (Bmk) or C (Ck), and occasionally with Ah or Ap (Ahk, Apk), or organic horizons (Ofk, Omk).

m A horizon slightly altered by hydrolysis, oxidation, or solution, or all three, to give a change in color or structure, or both. It has:

1. Evidence of alteration in one of the following forms:

   a) Higher chromas and redder hues than the underlying horizons.

   b) Removal of carbonates, either partially (Bmk) or completely (Bm).

2. Illuviation, if evident, too slight to meet the requirements of a Bt or a podzolic B.

3. Some weatherable minerals.

4. No cementation or induration and lacks a brittle consistence when moist. This suffix can be used as Bm, Bmgj, Bmk, and Bms.

n A horizon in which the ratio of exchangeable Ca to exchangeable Na is 10 or less. It must also have the following distinctive morphological characteristics: prismatic or columnar structure, dark coatings on ped surfaces, and hard to very hard consistence when dry. It is used with B, as Bn or Bnt.

p A horizon disturbed by man's activities, such as cultivation, logging, habitation, etc. It is used with A and O.

s A horizon with salts, including gypsum, which may be detected as crystals or veins, as surface crusts of salt crystals, by depressed crop growth, or by the presence of salt-tolerant plants. It is commonly used with C and k (Csk), but can be used with any horizon or combination of horizon and lowercase suffix.

sa A horizon with secondary enrich-

ment of salts more soluble than calcium and magnesium carbonates, in which the concentration of salts exceeds that present in the unenriched parent material. The horizon is 10 cm or more thick. The conductivity of the saturation extract must be at least 4 ms/cm and must exceed that of the C horizon by at least one-third.

t An illuvial horizon enriched with silicate clay. It is used with B alone (Bt), with B and g (Btg), with B and n (Bnt), etc.

Bt A Bt horizon is one that contains illuvial layer-lattice clays. It forms below an eluvial horizon, but may occur at the surface of a soil that has been partially truncated. It usually has a higher ratio of fine clay to total clay than IC. It has the following properties:

1. If any part of an eluvial horizon remains and there is no lithologic discontinuity between it and the Bt horizon, the Bt horizon contains more total and fine clay than the eluvial horizons, as follows:

   a) If any part of the eluvial horizon has less than 15% total clay in the fine earth fraction (2mm) the Bt horizon must contain at least 3% more clay, e.g.,Ae 12% clay-Bt minimum 15% clay.

   b) If the eluvial horizon has more than 15% and less than 40% total clay in the fine earth fraction, the ratio of the clay in the Bt horizon to that in the eluvial horizon must be 1.2 or more, e.g., 20% clay increase in the Bt over Ae.

   c) If the eluvial horizon has more than 40% total clay in the fine earth fraction, the Bt horizon must contain at least 8% more clay than the eluvial horizon, e.g. Ae 50% clay; Bt at least 58% clay.

2. A Bt horizon must be at least 5 cm thick. In some sandy soils where clay accumulation occurs in the lamellae, the total thickness of the lamellae should be more than 10 cm in the upper 150 cm of the profile.

3. In massive soils the Bt horizon should have oriented clays in some pores and also as bridges between the sand grains.

4. If peds are present, a Bt horizon shows clay skins on some of the vertical and horizontal ped surfaces and in the fine pores, or shows oriented clays in 1% or more of the cross section, as viewed in thin section.

5. If a soil shows a lithologic discontinuity between the eluvial

horizon and the Bt horizon, or if only a plow layer overlies the Bt horizon, the Bt horizon need show only clay skins in some part, either in some fine pores or on some vertical and horizontal ped surfaces. Thin sections should show that some part of the horizon has about 1% or more of oriented clay bodies.

Btj, Btj, and Btg are defined under j and g.

u A horizon that is markedly disrupted by physical or faunal processes other than cryoturbation. Evidence of marked disruption such as the inclusion of material from other horizons, absence of the horizon, etc. must be evident in at least half of the cross section of the pedon. Such turbation can result from blowdown of trees, mass movement of soil on slopes, and burrowing animals. It can be used with any horizon or subhorizon with the exception of A or B alone; e.g. Aeu, Bfu, BCu.

x A horizon of fragipan character. A fragipan is a loamy subsurface horizon of high bulk density and very low organic matter content. When dry, it has a hard consistence and seems to be cemented. When moist, it has moderate to weak brittleness. It frequently has bleached fracture planes and is overlain by a friable B horizon. Air dry clods of fragic horizons slake in water.

y A horizon affected by cryoturbation as manifested by disrupted and broken horizons,, incorporation of materials from other horizons and mechanical sorting in at least half of the cross section of the pedon. It is used with A, B, and C alone or in combination with other subscripts, e.g. Ahy, Ahgy, Bmy, Cy, Cgy, Cygj, etc.

z A frozen layer. It may be used with any horizon or layer, e.g. Ohz, Bmz, Cz, Wz.

Appendix C

DESCRIPTION OF LANDFORMS

C.1 GENETIC MATERIALS

Unconsolidated mineral component

The unconsolidated mineral component consists of clastic sediments that may or may not be stratified, but whose particles are not cemented together. They are essentially of glacial or post-glacial origin but include poorly consolidated and weathered bedrock.

Anthropogenic - Man-made or man-modified materials, including those associated with mineral exploitation and waste disposal.

Colluvial - Massive to moderately well stratified, nonsorted to poorly sorted sediments with any range of particle sizes from clay to boulders and blocks that have reached their present position by direct, gravity-induced movement.

They are restricted to products of mass-wasting whereby the debris is not carried by wind, water, or ice (excepting snow avalanches).

Eolian - Sediment, generally consisting of medium to fine sand and coarse silt particle sizes, that is well sorted, poorly compacted, and may show internal structures such as cross bedding or ripple laminae, or may be massive. Individual grains may be rounded and show signs of frosting.

These materials have been transported and deposited by wind action.

Fluvial - Sediment generally consisting of gravel and sand with a minor fraction of silt and clay. The gravels are typically rounded and contain interstitial sand. Fluvial sediments are commonly moderately to well sorted and display stratification, but massive, nonsorted fluvial gravels do occur. These materials have been transported and deposited by streams and rivers. Finer textured Fluvial deposits of modern rivers are termed Alluvium.

Lacustrine - Sediment generally consisting of either stratified fine sand, silt, and clay deposited on the lake bed; or moderately well sorted and stratified sand and coarser materials that are beach and other nearshore sediments transported and deposited by wave action.

These are materials that either have settled from suspension in bodies of standing fresh water or have accumulated at their margins through wave action.

Marine - Unconsolidated deposits of clay, silt, sand, or gravel that are well to moderately well sorted and well stratified to moderately stratified (in some places containing shells). They have settled from suspension in salt or brackish water bodies or have

accumulated at their margins through shoreline processes such as wave action and longshore drift.

Morainal - Sediment generally consisting of well compacted material that is nonstratified and contains a heterogeneous mixture of particle sizes, often in a mixture of sand, silt, and clay that has been transported beneath, beside, on, within and in front of a glacier and not modified by any intermediate agent.

Saprolite - Rock containing a high proportion of residual silts and clays formed by alteration, chiefly by chemical weathering.

The rock remains in a coherent state, interstitial grain relationships are undisturbed and no downhill movement due to gravity has occurred.

Undifferentiated - A layered sequence of more than three types of genetic material outcropping on a steep erosional escarpment.

Volcanic - Unconsolidated pyroclastic sediments. These include volcanic dust, ash, cinders, and pumice.

Qualifying Descriptors

These have been introduced to qualify the genetic materials and to supply additional information about the mode of formation or depositional environment.

Glacial - Used to qualify nonglacial genetic materials or process modifiers where there is direct evidence that glacier ice exerted a strong but secondary or indirect control upon the mode of origin of the materials or mode of operation of the process. The use of this qualifying descriptor implies that glacier ice was close to the site of the deposition of a material or the site of operation of a process.

Glaciofluvial - Fluvial materials showing clear evidence of having been deposited either directly in front of or in contact with glacier ice.

Glaciolacustrine - Lacustrine materials deposited in contact with glacial ice.

Glaciomarine - Materials of glacial origin laid down in a marine environment, as a result of settling from melting, floating ice and ice shelves.

Organic component

The organic component consists of peat deposits containing >30% organic matter by weight that may be as thin as 10 cm if they overlie bedrock but are otherwise greater than 40 cm and generally greater than 60 cm thick. The classes and their definitions follow.

B	Bog
N	Fen
S	Swamp

Bog - A bog is a peat-covered or peat-filled area, generally with a high water table. Since the surface of the peatland is slightly elevated, bogs are either unaffected or partly affected by nutrient-rich groundwaters from the surrounding mineral soils. The groundwater is generally acidic and low in nutrients (ombrotrophic). The dominant peat materials are sphagnum and forest peat, underlain, at times, by fen peat.

Fen - A fen is a peat-covered or peat-filled area with a high water table, which is usually at the surface. The dominant materials are shallow to deep, well to moderately decomposed fen peat. The waters are mainly rich in nutrients (minerotrophic) and are derived from mineral soils. The peat materials are therefore higher in both nutrients and pH than the peats associated with bogs.

Swamp - A swamp is a peat-covered or peat-filled area. The peat surface is level or slightly concave in cross section. The water table is frequently at or above the peat surface. There is strong water movement from margins or other mineral sources. The microrelief is hummocky, with many pools present. The waters are neutral or slightly acid. The dominant peat materials are shallow to deep mesic to humic forest and fen peat.

C.2 GENETIC MATERIAL MODIFIERS

Material modifiers are used to qualify unconsolidated mineral and organic deposits. Particle-size classes serve to indicate the size, roundness, and sorting of unconsolidated mineral deposits. Fiber classes indicate the degree of decomposition and fiber size of organic materials.

Particle size classes for unconsolidated mineral materials

Blocky: An accumulation of angular particles greater than 256 mm in size.

Bouldery: An accumulation of rounded particles greater than 256 mm in size.

Clayey: An accumulation of particles where the fine earth fraction contains 35% or more clay (<0.002 mm) by weight and particles greater than 2 mm are less than 35% by volume.

Cobbly: An accumulation of rounded particles having a diameter of 64-256 mm.

Gravelly: An accumulation of rounded particles ranging in size from pebbles to boulders.

Loamy: An accumulation of particles of which fine earth fraction contains 35% or less clay (<0.002 mm) by weight and particles greater than 2 mm are less than 35% by volume.

Pebbly: An accumulation of rounded particles having a diameter of 2-64 mm.

Rubbly: An accumulation of angular fragments having a diameter of 2-256 mm.

Sandy: An accumulation of particles of which the fine earth fraction contains more than 70% by weight of fine sand or coarser particles. Particles greater than 2 mm occupy less than 35% by volume.

Silty: An accumulation of particles of which the fine earth fraction contains less than 15% of fine sand or coarser particles and has less than 35% clay. Particles greater than 2 mm occupy less than 35% by volume.

Fiber classes for organic materials

The amount of fiber and its durability are important characterizing features of organic deposits in that they reflect on the degree of decomposition of the material. The prevalence of woody materials in peats is also of prime importance.

Fibric: The least decomposed of all organic materials; there is a large amount of well-preserved fiber that is readily identifiable as to botanical origin. Fibers retain their character upon rubbing.

Mesic: Organic material in an intermediate stage of decompostion; intermediate amounts of fiber are present that can be identified as to their botanical origin.

Humic: Highly decomposed organic material; small amounts of fiber are present that can be identified as to their botanical origin. Fibers can be easily destroyed by rubbing.

Woody: Organic material containing more than 50% of woody fibers.

C.3 SURFACE EXPRESSION

The surface expression of genetic materials is their form (assemblage of slopes) and pattern of forms. Form as applied to unconsolidated deposits refers specifically to the product of the initial mode of origin of the materials. When applied to consolidated materials, form refers to the product of their modification by geological processes. Surface expression also indicates the manner in which unconsolidated genetic materials relate to the underlying unit.

Consolidated and Unconsolidated mineral surface classes

Apron - A relatively gentle slope at the foot of a steeper slope and formed by materials from the steeper, upper slope.

Blanket - A mantle of unconsolidated materials thick enough to mask minor irregularities in the underlying unit but still conforming to the general underlying topography.

Fan - A fan-shaped form similar to the segment of a cone and having a perceptible gradient from the apex to the toe.

Hummocky - A very complex sequence of slopes extending from somewhat rounded depressions or kettles of various sizes to irregular to conical knolls or knobs. There is a general lack of concordance between knolls or depressions. Slopes are generally 9-70% (5-35 degrees).

Inclined - A sloping, unidirectional surface with a generally constant slope not broken by marked irregularities. Slopes are 2-70% (1-35 degrees). The form of inclined slopes is not related to the initial mode of origin of the underlying material.

Level - A flat or very gently sloping, unidirectional surface with a generally constant slope not broken by marked elevations and depressions. Slopes are generally less than 2% (1 degree).

Rolling - A very regular sequence of moderate slopes extending from rounded, sometimes confined concave depressions to broad, rounded convexities producing a wave-lake pattern of moderate relief. Slope length is often 1.6 km or

greater and gradients are greater than 5% (3 degrees).

Ridged - A long, narrow elevation of the surface, usually sharp crested with steep sides. The ridges may be parallel, subparallel, or intersecting.

Steep - Erosional slopes, greater than 70% (35 degrees), on both consolidated and unconsolidated materials. The form of a steep erosional slope on unconsolidated materials is not related to the initial mode of origin of the underlying material.

Terraced - Scarp face and the horizontal or gently inclined surface (tread) above it.

Undulating - A very regular sequence of gentle slopes that extends from rounded, sometimes confined concavities to broad rounded convexities producing a wavelike pattern of low local relief. Slope length is generally less than 0.8 km and the dominant gradient of slopes is 2-5% (1-3 degrees).

Veneer - Unconsolidated materials too thin to mask the minor irregularities of the underlying unit surface. A veneer will range from 10 cm to 1 m in thickness and will possess no form typical of the material's genesis.

Organic surface classes

Blanket - A mantle of organic materials that is thick enough to mask minor irregularities in the underlying unit but still conforms to the general underlying topography.

Bowl - A bog or fen occupying concave-shaped depressions.

Domed - A bog with an elevated, convex, central area much higher than the margin. Domes may be abrupt (with or without a frozen core) or gently sloping or have a stepped surface.

Floating - A level organic surface associated with a pond or lake and not anchored to the lake bottom.

Horizontal - A flat peat surface not broken by marked elevations and depressions.

Plateau - A bog with an elevated, flat, central area only slightly higher than the margin.

Ribbed - A pattern of parallel or reticulate low ridges associated with fens.

Sloping - A peat surface with a generally constant slope not broken by marked irregularities.

Veneer - A thin (40 cm-1m) mantle of organic materials which generally conforms to the underlying topography. They may or may not be associated with discontinuous permafrost.

Appendix D

SUPPLEMENTAL SOIL INFORMATION

Table 25. Summary of Soil Characteristics from Daily Field Records (CanSIS).

Series Code	Series Name	No. of Sites	Dominant Texture					Av.Thickness		Drainage	S. Runoff	Perv.	Erosion Water	Stoniness	Type	Slope		Land Use
			A	B	C	IIC	IIIC	A	A+B							Class	Position	
BAX	Banks	4	L	CL	CL	CL	-	16.5	39.2	Mod. Well	Slow	Mod.	-	N	C	0.5-2%	Middle	Crop Land
BHY	Bethany	7	LS-L	SCL	CoS	-	-	25.5	27.7	Imperfect	Mod.	Rapid	-	Mod.	C	2-5%	Lower	Crop Land
BKO	Breckon	11	C-CL	-	C	SiL	CoS	31.7	38.1	Poor	Very Slow	Slow	Mod.	N	C	0.0-0.5%	Depression	Fen/Crop Land
BWG	Bluewing	32	LFS	SCL	S	L	-	24.7	67.4	Well	Mod.	Rapid	Mod.	N	C	5-9%	Middle	Improved Pasture
BYH	Baynham	2	-	-	-	-	-	-	-	Very Poor	Ponded	-	-	-	-	-	Depression	Fen
CAY	Cayer	54	C	C	C	C	C	19.5	38.2	Very Poor	Very Slow	Mod.-Slow	-	N	S	0.0-0.5%	Depression	Fen
DKS	Dickson	10	SL	SCL	LS	CL	-	24.1	54.7	Imperfect	Slow	Mod.	-	N	C	0.5-2.0%	Middle	Crop Land
DVD	Davidson	81	LFS-LS	SCL	CoS-FS	L	-	25.2	59.2	Well	Mod.	Rapid	Slight	N	C	5-9%	Middle	Crop Land
ECK	Erickson	240	L	C	CL	L-CL	-	16.4	33.2	Well	Mod.	Mod.	Mod.	Slight	C	2-15%	Upper	Crop Land
HEC	Heron Creek	2	SL-L	-	CoS	-	-	30.0	30.0	Imp.-Poor	Slow	Mod.	-	M	S	0-2%	Depression	Marsh Prod. Woodl
KHI	Katherine	6	L	SCL	CoS	-	-	28.6	51.0	Imp.	Slow	M	Slight	Non	C	2-5%	Lower	Crop Land
KIC	Kircro	13	SL-L	-	CoS	SGR	-	10.0	10.0	Very Poor	Very Slow	Slow-Mod.	-	Non	Simple	0.0-0.5%	Dep.	Fen
LSW	Lenswood	1	SL	-	CoS	-	-	-	-	Imp.	Slow	M	-	Non	Simple	0.5-2%	Mid.	Crop Land
MWK	Meadowbrook	61	C	C	C	L	-	18.1	36.7	Well	Mod.	Slow	SL	Slight	C	2-9%	Middle	Crop Land
OKO	Okno	6	L	-	C-CL	SiCL	-	40.0	40.0	Very Poor	Very Slow	Mod.	-	Non	S	0.0-0.5%	Dep.	Bog
OOL	Onanole	68	L	C-CL	CL-SiL	-	-	19.9	48.5	Well	Mod.	Mod.	SL	N	C	5-9%	Upper	Crop Land
OZA	Ozerna	10	SL	SCL	LS	CL	-	25.1	56.1	Mod. W	Slow	Mod.	-	N	C	0.5-2%	Middle	Crop Land
PPL	Poppleton	14	SL	SCL	SL-LS	-	-	24.4	51.2	Imperfect	Slow	Mod.	Slight	N	C	0.0-5.0%	Mid-Lower	Crop Land
PTU	Petlura	48	CL	C	CL	-	-	23.0	48.7	Imp.	Mod.	Mod.	SL	Slight	C	2-5%	Lower	Crop Land
PVK	Proven Lake	37	L-CL	-	SiCL	-	-	29.3	34.4	Poor	Slow	Mod.	-	N	S	0.0-0.5%	Depression	Crop Land
PVK(p)	Proven Lake (peaty)	8	L	-	SiCL	-	-	16.0	22.0	Poor	Very Slow	Slow	-	N	S-C	0.5-2.0%	Depression	Nat. Grazing
RBN	Roblin	3	L	L	CL	-	-	24.3	61.6	Poor	Very Slow	Mod.-Slow	-	N	S	0.0-0.5%	Depression	Crop Land
RKH	Rackham	12	L-CL	C-CL	SiCL-SiL	-	-	14.6	45.0	Well	Mod.	Mod.	Mod.	N	C	5-9%	Upper	Crop Land
RTV	Rat River	3	-	-	LS	-	-	-	-	Very Poor	Very Slow	Rapid	-	N	S	0.0-0.5%	Middle	Bog
SHH	Seech	36	LFS-SL	CoS-SCL	CoS	CoS	SCL	18.1	31.8	Well	Rapid	Rapid	Slight	Slight-Mod.	C	9-15%	Crest	Crop Land
SHH(c)	Seech	28	SL	SCL	CoS	SGr	-	17.2	35.9	Well	Slow	Rapid	Slight	N	C	0.5-2%	Middle	Crop Land
SNT	Sinnott	34	L	CL	CL	CoS	L-SCL	27.5	30.1	Poor	Very Slow	Slow	Slight	N	S	0.0-0.5%	Depression	Marsh-Fen
SNT(p)	Sinnott	8	C	C	C	L	-	35.0	35.0	Poor	Very Slow	Slow	-	N	S	0.0-0.5%	Depression	Marsh
STD	Stead	11	-	-	C	-	-	-	-	Very Poor	Ponded	Moderately	-	N	S	0.0-0.5%	Depression	Fen
SWF	Swanford	3	L	-	SiL-L	C	-	15.0	40.0	Imperfect	Slow	Mod.	-	N	C	0.0-0.5%	Middle	Improved Pasture
SWN	Swan	14	L	C	CL	-	-	17.0	42.1	Imperfect	Slow	Slow	Slight	N	C	2-5%	Upper	Crop Land
TEK	Tee Lake	2	CL	C	L	-	-	11.0	31.0	Imperfect	Slow	Mod.	-	N	S	0.0-0.5%	Depression	Natural Grazing
VLY	Valley	6	CL	-	SiCL	-	-	23.3	23.3	Imperfect	Slow	Mod.	-	N	S	0.5-2%	Depression	Crop Land
VST	Vista	28	FSL-LS	FS-LS	FS-S	CoS-CoSL	-	28.3	34.2	Poor	Slow	Mod.	-	N	S	0.0-2.0%	Depression	Improved/Nat. Gra
VST(p)	Vista (peaty)	2	LS-SCL	-	LS-SCL	-	-	10.0	10.0	Very Poor	Ponded	Mod.	-	N	C	0.5-2.0%	Depression	Marsh
WLM	Wellman	11	L-C	C	C	-	-	20.5	42.5	Imperfect	Slow	Slow	Slight	Slight	C	2-5%	Lower	Crop Land
WTV	Waitville	94	L	C	CL	L	-	15.1	37.0	Well	Mod.	Slow	Mod.	Moderate	C	9-15%	Middle	Crop Land
ZAP	Zaparoza	35	LS-SL	SCL-SC	CoS	VFSL-LVFS	-	15.5	34.4	Well	Mod.	Mod.	Mod.	Slight	C	9-15%	Middle	Crop Land

Stoniness	Type	Slope		Land Use	Soil Class	Surface Deposit
		Class	Position			
N	C	0.5-2%	Middle	Crop Land	O.DG	Lacustrine
Mod.	C	2-5%	Lower	Crop Land	GLR.BL	Fluvial
N	C	0.0-0.5%	Depression	Fen/Crop Land	R.HG	Morainal Till
N	C	5-9%	Middle	Improved Pasture	D.GL	Fluvio-Lacustrine
-	-	-	Depression	Fen	TY.M	Organic
N	S	0.0-0.5%	Depression	Fen	T.M	Organic
N	C	0.5-2.0%	Middle	Crop Land	GL.DG	Lacustrine
N	C	5-9%	Middle	Crop Land	O.DG	Fluvio-Lacustrine
Slight	C	2-15%	Upper	Crop Land	O.DG	Morainal Till
N	S	0-2%	Depression	Marsh Prod. Woodland	R.HG	Fluvial
Non	C	2-5%	Lower	Crop Land	GL.DG	Fluvial
Non	Simple	0.0-0.5%	Dep.	Fen	T.M	Organic
Non	Simple	0.5-2%	Mid.	Crop Land	GLR.BL	Fluvial
Slight	C	2-9%	Middle	Crop Land	O.DG	Morainal Till
Non	S	0.0-0.5%	Dep.	Bog	T.M	Organic
N	C	5-9%	Upper	Crop Land	O.DG	Lacustrine
N	C	0.5-2%	Middle	Crop Land	O.DG	Lacustrine
N	C	0.0-5.0%	Mid-Lower	Crop Land	GL.DG	Lacustrine
Slight	C	2-5%	Lower	Crop Land	GL.DG	Morainal Till
N	S	0.0-0.5%	Depression	Crop Land	R.HG	Lacustrine
N	S-C	0.5-2.0%	Depression	Nat. Grazing	R.HG	Lacustrine
N	S	0.0-0.5%	Depression	Crop Land	HU.LG	Morainal Till
N	C	5-9%	Upper	Crop Land	O.GL	Lacustrine
N	S	0.0-0.5%	Middle	Bog	T.M	Organic
Slight-Mod.	C	9-15%	Crest	Crop Land	CA.BL	Fluvial
N	C	0.5-2%	Middle	Crop Land	O.BL	Fluvial
N	S	0.0-0.5%	Depression	Marsh-Fen	R.HG	Morainal Till
N	S	0.0-0.5%	Depression	Marsh	R.HG	Morainal Till
N	S	0.0-0.5%	Depression	Fen	TY.M	Organic
N	C	0.0-0.5%	Middle	Improved Pasture	GLR.BL	Lacustrine
N	C	2-5%	Upper	Crop Land	GL.DG	Lacustrine
N	S	0.0-0.5%	Depression	Natural Grazing	GL.GL	Morainal Till
N	S	0.5-2%	Depression	Crop Land	GLR.BL	Lacustrine
N	S	0.0-2.0%	Depression	Improved/Nat. Grazing	R.HG	Lacustrine
N	C	0.5-2.0%	Depression	Marsh	R.HG	Lacustrine
Slight	C	2-5%	Lower	Crop Land	GL.DG	Morainal Till
Moderate	C	9-15%	Middle	Crop Land	O.GL	Morainal Till
Slight	C	9-15%	Middle	Crop Land	O.GL	Fluvial

Appendix E

GUIDES FOR EVALUATING SOIL SUITABILITY FOR SELECTED USES

Table 26. Guide for assessing soil suitability as source of topsoil.

The term "topsoil" includes soil materials used to cover barren surfaces exposed during construction, and materials used to improve soil conditions on lawns, gardens, flower beds, etc. The factors to be considered include not only the characteristics of the soil itself, but also the ease or difficulty of excavation, and where removal of topsoil is involved, accessibility to the site.

Symbol[1]	Items Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
u	Moist Consistence[2]	Very friable, friable	Loose, firm	Very firm	Cemented
i	Flooding	None	May flood occasionally for short periods	Frequent flooding	Constantly flooded
w	Wetness[2]	Wetness is not determining if better than very poorly drained.			Very poorly drained and permanently wet soils
t	Slope	0-5%	5-9%	9-15%	>15%
p	Stoniness[2]	Stones 10 m apart (Class 0 and 1)	Stones 2-10 m apart (Class 2)	Stones 0.1-2 m apart (Class 3 and 4)	Stones 0.1 m apart (Class 5)
c	Coarse fragments[2]: percent, by volume	<3%	3-15%	15-35%	>35%
s	Texture[2]	FSL, VFSL, L, SiL, SL, SC if 1:1 clay is dominant	CL, SCL, SiCL, SC if 2:1 clay is dominant; c and sic if 1:1 clay is dominant	S, LS, C and SiC if 2:1 clay is dominant. organic soils[3]	Marl, diatomaceous earth
b	Depth of Topsoil[4]	>40 cm	15-40 cm	8-15 cm	<8 cm
n	Salinity of Topsoil[5]	E.C. 0-1	E.C. 1-4	E.C. 4-8	E.C. >8

1/ The symbols are used to indicate the nature of the limitation.

2/ For an explanation of texture, consistence, stoniness, coarse fragments and soil drainage classes, see the Manual for Describing Soils in the Field (Canada Soil Survey Committee, 1978).

3/ Non-woody organic materials are assessed as good sources for topsoil if mixed with or incorporated into mineral soil.

4/ The remaining soil material (at least 8 cm) must be reclaimable after the uppermost soil is removed.

5/ E.C. = Electrical Conductivity (millisiemens/cm).

Table 27. Guide for assessing soil suitability as source of sand and gravel.

The purpose of this table is to provide guidance for assessing the probable supply as well as quality of the sand or gravel for use as road base material and in concrete. The interpretation pertains mainly to the characteristics of the soil substratum to a depth of 150 cm, augmented by observations made in deep cuts as well as geological knowledge where available.

Symbol[1/]	Items Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
a	Unified Soil Group	SW SP GW GP	SW-SM SP-SM GP-GM GW-GM	SM SW-SC SP-SC GM GP-GC GW-GC	All other groups and bedrock
h	Depth to Seasonal Water Table	Not class determining if deeper than 50 cm		50 cm	
q	Depth to Sand and Gravel	<25 cm	25-75 cm[2/]	>75 cm[2/]	
p	Stoniness[3/]	Not class determining if stones >.5 m apart (Class 0, 1, 2 and 3)		Stones 0.1-0.5 m apart (Class 4)	Stones <0.1 m apart (Class 5)
d	Depth to Bedrock	>100 cm	50-100 cm	<50 cm	

1/ The symbols are used to indicate the nature of the limitation.

2/ Rated good if it is known that the underlying gravel or sand deposit is thick (>100 cm).

3/ For an explanation of stoniness and rockiness, see the Manual for Describing Soils in the Field (Canad. Soil Survey Committee, 1978).

Table 28. Guide for assessing soil suitability as source of roadfill.

Fill material for buildings or roads are included in this use. The performance of the material when removed from its original location and placed under load at the building site or road bed are to be considered. Since surface materials are generally removed during road or building construction their properties are disregarded. Aside from this layer, the whole soil to a depth of 150-200 cm should be evaluated. Soil materials which are suitable for fill can be considered equally suited for road subgrade construction.

Symbol[1]	Items Affecting Use[2]	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
s	Subgrade[3]				
	a. AASHO group index[4]	0-4	5-8	>8	
	b. Unified soil classes	GW, GP, SW, SP, SM, GC[5] and SC[5]	CL (with P.I.[6] <15) and ML	CL (with P.I.[6] of 15 or more), CH and MH[7]	OL, OH and Pt
l	Shrink-swell potential	Low	Moderate	High	
f	Susceptibility to frost action[8]	Low	Moderate	High	
k	Slope	0-11%	15-30%	30-45%	>45%
p	Stoniness[9]	Stones >2 m apart (Class 0, 1 and 2)	Stones 0.5-2 m apart (Class 3)	Stones 0.1-0.5 m apart (Class 4)	Stones <0.1 m apart (Class 5)
r	Rockiness[9]	Rock exposures >35 m apart and cover <10% of the surface	Rock exposure 10-35 m apart and cover 10-25% of the surface	Rock exposure 3.5-10 m apart and cover 25-50% of the surface	Rock exposure <3.5 m apart and cover 50-90% of the surface
w	Wetness[9]	Excessively drained to moderately well drained	Imperfectly drained	Poorly drained	Very poorly drained or permanently wet soils
d	Depth to Bedrock	>100 cm	50-100 cm	20-50 cm	<20 cm
h	Depth to Seasonal Water Table	>150 cm	75-150 cm	50-75 cm	<50 cm

[1] The symbols are used to indicate the nature of the limitation.

[2] The first three items pertain to soil after it is placed in a fill; the last six items pertain to soil in its natural condition before excavation for road fill.

[3] This item evaluates the strength of the soil material, that is, its ability to withstand applied loads.

[4] Use AASHO group index only where laboratory data are available for the kind of soil being rated; otherwise, use Unified soil groups.

[5] Downgrade suitability rating to fair if content of fines is more than about 30 percent.

[6] P.I. mean plasticity index.

[7] Upgrade suitability rating to fair if MH is largely kaolinitic, friable, and free of mica.

[8] Use this item only where frost penetrates below the paved or hardened surface layer and where moisture transportable by capillary movement is sufficient to form ice lenses at the freezing front.

[9] For an explanation of stoniness, rockiness and soil drainage classes, see the Manual for Describing Soils in the Field (Canada Soil Survey Committee, 1978).

Table 29. Guide for assessing soil suitability for permanent buildings[1].

This guide applies to undisturbed soils to be evaluated for single-family dwellings and other structures with similar foundation requirements. The emphasis for rating soils for buildings is on foundation requirements; but soil slope, susceptibility to flooding and other hydrologic conditions, such as wetness, that have effects beyond those related exclusively to foundations are considered too. Also considered are soil properties, particularly depth to bedrock, which influence excavation and construction costs for the building itself and for the installation of utility lines. Excluded are limitations for soil corrosivity, landscaping and septic tank absorption fields.

Symbol[2]	Items Affecting Use	Degree of Soil Suitability[3]			
		Good - G	Fair - F	Poor - P	Very Poor - V
w	Wetness[4]	With Basements: Very rapidly, rapidly and well drained. Without Basements: Very rapidly, rapidly, well and moderately well drained.	With Basements: Moderately well drained. Without Basements: Imperfectly drained.	With Basements: Imperfectly, poorly, and very poorly drained. Without Basements: Poorly and very poorly drained.	With Basements: Permanently wet soils. Without Basements: Permanently wet soils.
h	Depth to Seasonal Water Table	With Basements: >150 cm Without Basements: >75 cm	With Basements: 75-150 cm Without Basements: 50-75 cm	With Basements: 25-75 cm Without Basements: 25-50 cm	With Basements: <25 cm Without Basements: <25 cm
i	Flooding	None	None	Occasional flooding (once in 5 years)	Frequent flooding (every year)
t	Slope[5]	0-9%	9-15%	15-30%	>30%
s	Subgrade[6]				
	a. AASHO group index[7]	0-4	5-8	>8	
	b. Unified soil classes	GW, GP, SW, SP, SM and GC and SC	CL (with P.I.[8] <15) and ML	CL (with P.I.[8] of 15 or more), CH and MH	OH, OL and Pt
f	Potential Frost Action[9]	Low (F1, F2)	Moderate (F3)	High (F4)	
p	Stoniness[4]	Stones >10 m apart (Class 0 to 1)	Stones 2-10 m apart (Class 2[10])	Stones 0.1-2 m apart (Class 3[10] to 4)	Stones <0.1 m apart (Class 5[10])
r	Rockiness[4],[11]	Rock exposures >100 m apart and cover <2% of the surface	Rock exposures 30-100 m apart and cover 2-10% of the surface	Rock exposures <30 m apart and cover >10% of the surface	Rock exposures too frequent to allow location of permanent buildings
d	Depth to Bedrock[11]	With Basements: >150 cm Without Basements: >100 cm	With Basements: 100-150 cm Without Basements: 50-100 cm	With Basements: 50-100 cm Without Basements: <50 cm	With Basements: <50 cm

1/ By halving the slope limits, this table can be used for evaluating soil suitability for buildings with large floor areas, but with foundation requirements not exceeding those of ordinary three-storey dwellings.

2/ The symbols are used to indicate the nature of the limitation.

3/ Some soils assessed as fair or poor may be good sites from an aesthetic or use standpoint, but they will require more site preparation and/or maintenance.

4/ For an explanation of rockiness, stoniness and soil drainage classes, see the Manual for Describing Soils in the Field (Canada Soil Survey Committee, 1978).

5/ Reduce the slope limits by one half for those soils subject to hillside slippage.

6/ This item estimates the strength of the soil, that is, its ability to withstand applied loads. When available, AASHO Group Index values from laboratory tests were used; otherwise the estimated Unified classes were used.

7/ Group index values were estimated from information published by the Portland Cement Association (PCA, 1962), pp. 23-25.

8/ P.I. means plasticity index.

9/ Frost heave only applies where frost penetrates to the assumed depth of the footings and the soil is moist. The potential frost action classes are taken from the United States Army Corps of Engineers (1962), pp. 5-8.

10/ Rate one class better for buildings without basements.

11/ Rate one class better if the bedrock is soft enough so that it can be dug with light power equipment such as backhoes.

Table 30. Guide for assessing soil suitability for local roads and streets[1/].

This guide applies to soils to be evaluated for construction and maintenance of local roads and streets. These are improved roads and streets having some kind of all-weather surfacing, commonly asphalt or concrete, and are expected to carry automobile traffic all year. They consist of: (1) the underlying local soil material (either cut or fill) called the subgrade; (2) the base material of gravel, crushed rock, or lime or soil cement stabilized soil called the subbase; and (3) the actual road surface or pavement, either flexible or rigid. They also are graded to shed water and have ordinary provisions for drainage. With the probable exception of the hardened surface layer, the roads and streets are built mainly from the soil at hand, and cuts and fills are limited, usually less than 2 meters. Excluded from consideration in this guide are highways designed for fast-moving, heavy trucks.

Properties that affect design and construction of roads and streets are: (1) those that affect the load supporting capacity and stability of the subgrade, and (2) those that affect the workability and amount of cut and fill. The AASHO and Unified Classification give an indication of the traffic supporting capacity. Wetness and flooding affect stability. Slope, depth of hardrock, stoniness, rockiness, and wetness affect the ease of excavation and the amount of cut and fill to reach an even grade.

Symbol[2/]	Items Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
w	Wetness[3/]	Very rapidly, rapidly, well and moderately well drained	Imperfectly drained	Poorly and very poorly drained	Permanently wet soils
i	Flooding	None	Infrequent (once in 5 years)	Occasional (once in 2-4 years)	Frequent (every year)
t	Slope	0-9%	9-15%	15-30%	>30%
d	Depth to Bedrock[4/]	>100 cm	50-100 cm	<50 cm	
s	Subgrade[5/]				
	a. AASHO group index[6/]	0-4	5-8	>8	
	b. Unified soil classes	GW, GP, SW, SP, SM, GC[7/] and SC[7/]	CL (with P.I.[8/] <15) and ML	CL (with P.I.[8/] of 15 or more), CH and MH	OH, OL and Pt
f	Susceptibility to Frost Heave[9/]	Low (F1, F2)	Moderate (F3)	High (F4)	
p	Stoniness[3/]	Stones >2 m apart (Class 0 to 2)	Stones 0.5-2 m apart (Class 3)	Stones 0.1-0.5 m apart (Class 4)	Stones <0.1 m apart (Class 5)
r	Rockiness[3/]	Rock exposures >100 m apart and cover <2% of the surface	Rock exposures 30-100 m apart and cover 2-10% of the surface	Rock exposures <30 m apart and cover >10% of the surface	Rock exposures too frequent to permit location of roads and streets

1/ These guidelines, with some adjustment of slope and rockiness limits, will also be useful for assessing soils for use as parking lots.

2/ Symbols are used to indicate the nature of the limitation.

3/ For an explanation of stoniness, rockiness and soil drainage classes, see the Canada Soil Information System (Canada Soil Survey Committee, 1978).

4/ Rate one class better if the bedrock is soft enough so that it can be dug with light power equipment and is rippable by machinery.

5/ This item estimates the strength of soil materials as it applies to roadbeds. When available, AASHO Group Index values from laboratory tests were used; otherwise, the estimated Unified classes were used. The limitations were estimated assuming that the roads would be surfaced. On unsurfaced roads, rapidly drained, very sandy, poorly graded soils may cause washboard or rough roads.

6/ Group index values were estimated from information published by the Portland Cement Association (PCA, 1962) pp. 23-25

7/ Downgrade to moderate if content of fines (less than 200 mesh) is greater than about 30 percent.

8/ P.I. means plasticity index.

9/ Frost heave is important where frost penetrates below the paved or hardened surface layer and moisture transportable by capillary movement is sufficient to form ice lenses at the freezing point. The susceptibility classes are taken from the United States Army Corps of Engineers (1962) pp. 5-8.

Table 31. Guide for assessing soil suitability for trench-type sanitary landfills[1].

The trench-type sanitary landfill is a sanitary landfill, in which dry garbage and trash is buried daily in an open trench and covered with a layer of soil material. Suitability of the site is dependent upon the potential for pollution of water sources through groundwater contact with the refuse, or leachate arising from the site. Those properties affecting ease of excavation of the site must be supplemented with geological and hydrological knowledge to provide subsurface soil and groundwater data to a depth of at least 3 to 4.5 m, a common depth of landfills.

Symbol[2]	Items Affecting Use	Degree of Soil Suitability			
		Good - G[3]	Fair - F	Poor - P	Very Poor - V
h	Depth to Seasonal High Water Table	Not class determining if more than 180 cm		100-180 cm	<100 cm
w	Wetness[4]	Not class determining if better than imperfectly drained		Imperfectly drained	Poorly and very poorly drained or permanently wet soils
i	Flooding	None	Rare	Occasional	Frequent
k	Permeability[5]	<5 cm/hr	<5 cm/hr	5-15 cm/hr	>15 cm/hr
t	Slope	0-15%	15-30%	30-45%	>45%
s	Soil Texture[4],[6] (dominant to a depth of 150 cm)	SL, L, SiL, SCL	SiCL[7], CL, SC, LS	SiC, C	Muck, peat, gravel, sand
d	Depth to Hard Bedrock Rippable	>150 cm >150 cm	>150 cm 100-150 cm	100-150 cm 100-150 cm	<100 cm <100 cm
p	Stoniness[4]	Stones >10 m apart (Class 0 and 1)	Stones 2-10 m apart (Class 2)	Stones 0.1-2 m apart (Class 3 and 4)	Stones <0.1 m apart (Class 5)
r	Nature of Bedrock	Impermeable			Highly permeable, fractured, easily soluble

1/ Based on soil depth (120 cm) commonly investigated in making soil surveys.

2/ The symbols are used to indicate the nature of the limitation.

3/ If probability is high that the soil material to a depth of 3 to 4.5 m will not alter a rating of good or fair, indicate this by an appropriate footnote, such as "Probably good to a depth of 3.5 m", or "Probably fair to a depth of 3.5 m".

4/ For an explanation of stoniness, texture and soil drainage classes, see the Manual for Describing Soils in the Field (Canada Soil Survey Committee, 1978).

5/ Reflects ability of soil to retard movement of leachate from the landfills; may not reflect a limitation in arid and semiarid areas.

6/ Reflects ease of digging and moving (workability) and trafficability in the immediate area of the trench where there may not be surfaced roads.

7/ Soils high in expansive clays may need to be given a suitability rating of poor.

Table 32. Guide for assessing soil suitability as cover material for area-type sanitary landfills.

The term cover material includes soil materials used to put a daily and final covering layer on refuse in area-type sanitary landfills. This cover material may be derived from the area of the landfill or may be brought in from surrounding areas.

Symbol[1]	Items Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
u	Moist Consistence[2]	Very friable, friable	Loose, firm	Very firm	Cemented
s	Texture[2],[3]	SL, L, SiL, SCL	SiCL, CL, SC, LS	SiC, C	Muck, peat, sand, gravel
d	Depth to bedrock[4]	>150 cm	100-150 cm	50-100 cm	<50 cm
c	Coarse fragments[2]	<15%	15-35%	>35%	
p	Stoniness[2]	Stones >10 m apart (Class 0 and 1)	Stones 2-10 m apart (Class 2)	Stones 0.1-2 m apart (Class 3 and 4)	Stones <0.1 m apart (Class 5)
t	Slope	<9%	9-15%	15-30%	>30%
w	Wetness[2]	Not class determining if better than poorly drained		Poorly drained	Very poorly drained or permanently wet soils

1/ The symbols are used to indicate the nature of the limitation.

2/ For an explanation of consistence, texture, coarse fragments, stoniness and soil drainage classes, see the Manual for Describing Soils in the Field (Canada Soil Survey Committee, 1978).

3/ Soils having a high proportion of non-expansive clays may be given a suitability rating one class better than is shown for them in this table.

4/ Thickness of material excluding topsoil, which will be stockpiled (see guide for topsoil).

Table 33. Guide for assessing soil suitability for area-type sanitary landfills.

In the area-type sanitary landfill, refuse is placed on the surface of the soil in successive layers. The daily and final cover material generally must be imported. A final cover of soil material at least 60 cm thick is placed over the fill when it is completed.

The soil under the proposed site should be investigated so as to determine the probability that leachates from the landfill can penetrate the soil and thereby pollute water supplies.

Symbol[1]	Item Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
h	Depth to Seasonal Water Table[2]	>150 cm	150-100 cm	50-100 cm	<50 cm
w	Wetness[2],[3]	Rapid to moderately well drained	Imperfectly drained	Poorly drained	Very poorly drained or permanently wet soils
i	Flooding	None	Rare	Occasional	Frequent
k	Permeability[4],[5]	Not class determining if less than 5 cm/hr		5-15 cm/hr	>15 cm/hr
t	Slope	0-9%	9-15%	15-30%	>30%

[1] The symbols are used to indicate the nature of the limitation.

[2] Reflects influence of wetness on operation of equipment.

[3] For an explanation of drainage, see the Manual for Describing Soils in the Field (Canada Soil Survey Committee, 1978).

[4] Reflects ability of the soil to retard movement of leachate from landfills; may not reflect a limitation in arid and semiarid areas.

[5] Due to possible groundwater contamination, impermeable bedrock is considered poor and permeable bedrock is rated very poor for area-type sanitary landfills.

Table 34. Guide for assessing soil suitability for reservoirs and sewage lagoons.

Factors affecting the ability of undisturbed soils to impound water or sewage and prevent seepage are considered for evaluating soils on their suitability for reservoir and lagoon areas. This evaluation considers soil both as a vessel for the impounded area and as material for the enclosing embankment. As the impounded liquids could be potential sources of contamination of nearby water supplies, e.g. sewage lagoons, the landscape position of the reservoir as it affects risk of flooding must also be considered.

Symbol[1]	Items Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
h	Depth to Water Table[2]	>150 cm	100-150 cm	50-100 cm	<50 cm
i	Flooding[3]	None	None	Subject to infrequent flooding (once in 50 years)	Subject to frequent high level flooding
k	Soil Permeability	0-0.5 cm/hr	0.5-5 cm/hr	5-15 cm/hr	>15 cm/hr
t	Slope	0-2%	2-5%	5-9%	>9%
o	Organic Matter	<2%	2-10%	10-30%	>30%
c	Coarse Fragments[4] <25 cm in diameter, % by volume	<20%	20-35%	>35%	
p	Stoniness[4], >25 cm diameter, percent of surface area	<3% (Class 0, 1 and 2)	3-15% (Class 3)	15-50% (Class 4)	>50% (Class 5)
d	Depth to Bedrock[5]	>150 cm	100-150 cm	50-100 cm	<50 cm
j	Thickness of Slowly Permeable Layer	>100 cm	50-100 cm	50-25 cm	<25 cm
a	Subgrade Unified Soil Classes	GC, SC, CL, & CH	GM, ML, SM & MH	SW & SP	OL, OH & Pt GP, GW

1/ The symbols are used to indicate the nature of the limitation.

2/ If the floor of the lagoon has nearly impermeable material at least 50 cm thick, disregard depth to water table.

3/ Disregard flooding if it is not likely to enter or damage the lagoon (flood waters have low velocity and depth less than 150 cm).

4/ For an explanation of coarse fragments and stoniness classes, see the Manual for Describing Soils in the Field (Canada Soil Survey Committee, 1978).

5/ Surface exposures of non rippable rock are rated very poor. If underlying bedrock is impermeable, rating should be one class better.

Table 35. Guide for assessing soil suitability for septic tank absorption fields.

This guide applies to soils to be used as an absorption and filtering medium for effluent from septic tank systems. A subsurface tile system laid in such a way that effluent from the septic tank is distributed reasonably uniformly into the natural soil is assumed when applying this guide. A rating of poor need not mean that a septic system should not be installed in the given soil, but rather, may suggest the difficulty, in terms of installation and maintenance, which can be expected.

Symbol[1]	Items Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
k	Permeability[2]	Rapid to moderately rapid	Moderate	Slow	Very slow
	Percolation Rate[3] (Auger hole method)	About 8-18 min/cm[3]	18-24 min/cm	Slower than 24 min/cm	
h	Depth to Seasonal Water Table[4]	>150 cm[5]	100-150 cm	50-100 cm	<50 cm
i	Flooding	Not subject to flooding	Not subject to flooding	Subject to occasional flooding (once in 5 years)	Floods every year
t	Slope	0-9%	9-15%	15-30%	>30%
d	Depth to Hard Rock, bedrock or other impervious materials	>150 cm	100-150 cm[6]	50-100 cm	<50 cm

1/ The symbols are used to indicate the nature of the limitation.

2/ The suitability ratings should be related to the permeability of soil layers at and below depth of the tile line.

3/ Soils having a percolation rate less than about 8 min/cm are likely to present a pollution hazard to adjacent waters. This hazard must be noted, but the degree of hazard must, in each case, be assessed by examining the proximity of the proposed installation to water bodies, water table, and related features. The symbol g is used to indicate this condition. Refer to U.S. Dept. of Health, Education and Welfare (1969) for details of this procedure.

4/ Seasonal means for more than one month. It may, with caution, be possible to make some adjustment for the severity of a water table limitation in those cases where seasonal use of the facility does not coincide with the period of high water table.

5/ A seasonal water table should be at least 100 cm below the bottom of the trench at all times for soils rated Good (U.S. Dept. of Health, Education and Welfare, 1969). The depths used to water table are based on an assumed tile depth of 50 cm. Where relief permits, the effective depth above a water table or rock can be increased by adding appropriate amounts of fill.

6/ Where the slope is greater than 9%, a depth to bedrock of 100-150 cm is assessed as poor.

Table 36. Guide for assessing soil suitability for playgrounds.

This guide applies to soils to be used intensively for playgrounds for baseball, football, badminton, and for other similar organized games. These areas are subject to intensive foot traffic. A nearly level surface, good drainage, and a soil texture and consistence that gives a firm surface generally are required. The most desirable soils are free of rock outcrops and coarse fragments.

Soil suitability for growing and maintaining vegetation is not a part of this guide, except as influenced by moisture, but is an important item to consider in the final evaluation of site.

Symbol[1]	Item Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
w	Wetness[2]	Rapidly, well and moderately well drained soils with no ponding or seepage. Water table below 75 cm during season of use.	Moderately well drained soils subject to occasional seepage or ponding of short duration and imperfectly drained soils. Water table below 50 cm during season of use.	Imperfectly drained soils subject to seepage or ponding, and poorly drained soils. Water table above 50 cm during season of use.	Very poorly drained and permanently wet soils.
i	Flooding	None during season of use.	Occasional flooding. May flood once every 2-3 years during season of use.	Floods every year during season of use.	Prolonged flooding during season of use.
k	Permeability	Very rapid to moderate.	Moderately slow and slow.	Very slow.	
t	Slope	0-2%	2-5%	5-9%	>9%
d	Depth to Bedrock	>100 cm	50-100 cm[3]	<50 cm[3]	
c	Coarse fragments on surface[2]	Relatively free of coarse fragments.	<20% coarse fragments.	>20% coarse fragments.	
p	Stoniness[2]	Stones >10 m apart. (Class 0 to 1)	Stones 2-10 m apart. (Class 2)	Stones 0.1-2 m apart. (Class 3, 4)	Stones <0.1 m apart. (Class 5)
r	Rockiness[2]	Rock exposures >100 m apart and cover <2% of the surface.	Rock exposures 30-100 m apart and cover about 2-10% of the surface.	Rock exposures <30 m apart and cover >10% of the surface.	Rock outcrops too frequent to permit playground location.
e	Surface Soil Texture[2,4]	SL, FSL, VFSL, L	SiL, CL, SCL, SiCL, LS	SC, SiC, C[5]; S, Si	Peaty soils; S and LS subject to blowing.
q	Depth to Sand or Gravel[6]	>100 cm	50-100 cm	<50 cm	
m	Useful Moisture[2]	Water storage capacity[7] >15.0 cm and/or adequate rainfall and/or low evapotranspiration.	Water storage capacity[7] 7.5-15 cm and/or moderate rainfall and/or moderate evapotranspiration.	Water storage capacity[7] <7.5 cm and/or low rainfall and/or high evapotranspiration.	

1/ The symbols are used to indicate the nature of the limitation.

2/ See also definitions for coarse fragments, rockiness, stoniness, textural and soil drainage classes in the Manual for Describing Soils in the Field (Canada Soil Survey Committee, 1978).
Coarse fragments for the purpose of this table include gravels and cobbles.

3/ Downgrade to a very poor suitability rating if the slope is greater than 9%.

4/ Surface soil texture influences soil ratings as it affects foot trafficability, surface wetness, dust, and maintenance. Adverse soil textures may be partially or completely overcome with the addition of topsoil.

5/ Moderately well and well drained SC, SiC and C soils may be rated fair.

6/ Depth to sand or gravel is considered a limitation in that levelling operations may expose sand or gravel, thereby bringing about adverse surface textures and undesirable amounts of coarse fragments. The addition of topsoil after the levelling process would overcome this limitation.

7/ This item attempts to evaluate the adequacy of moisture for vegetative growth. It incorporates the concept of supply through rainfall, loss through evapotranspiration, and storage within the rooting zone. In soils where the water table is within rooting depth for a significant portion of the year, water storage capacity may not significantly influence vegetation growth.

8/ Consult glossary for definitions of terms used.

Table 27. Guide for assessing soil suitability for camp areas.

This guide applies to soils to be used intensively for tents and camp trailers and the accompanying activities of outdoor living. It is assumed that little site preparation will be done other than shaping and levelling for campsites and parking areas. The soil should be suitable for heavy foot traffic by humans and limited vehicular traffic. Soil suitability for growing and maintaining vegetation is not a part of this guide, but is an important item to consider in the final evaluation of site.

Back country campsites differ in design, setting and management but require similar soil attributes. These guides should apply to evaluations for back country campsites but depending on the nature of the facility the interpreter may wish to adjust the criteria defining a given degree of limitation to reflect the changed requirement. For example, small tentsites may allow rock exposures greater than 10 m apart to be considered a slight limitation.

Symbol[1]	Item Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
w	Wetness[2]	Very rapidly, rapidly, well and moderately well drained soils with no seepage or ponding. Water table below 75 cm during season of use.	Moderately well drained soils subject to occasional seepage or ponding and imperfectly drained soils with no seepage or ponding. Water table below 50 cm during season of use.	Imperfectly drained soils subject to seepage or ponding and poorly drained soils. Water table above 50 cm during season of use.	Very poorly drained and permanently wet soils.
f	Flooding	None	Very occasional flooding during season of use. Once in 5-10 years.	Occasional flooding during season of use. Once in 2-4 years.	Flooding during every season of use.
k	Permeability	Very rapid to moderate inclusive.	Moderately slow and slow.	Very slow.	
t	Slope	0-9%	9-15%	15-30%	>30%
e	Surface Soil Texture[2,3]	SL, FSL, VFSL, L	SiL, SCL, CL, SiCL, LS, and sand other than loose sand.	SC, SiC, C[4]; S	Peaty soils; loose sand subject to blowing.
c	Coarse Fragments on Surface[2,5]	0-20%	20-50%	>50%	
p	Stoniness[2,6]	Stones >10 m apart (Class 0 and 1)	Stones 2-10 m apart (Class 2)	Stones 0.1-2 m apart (Class 3 and 4)	Stones < 0.1 m apart (Class 5)
r	Rockiness[2,6]	No rock exposures	Rock exposures >10 m apart and cover <25% of the area.	Rock exposures <10 m apart and cover >25% of the area.	Rock exposures too frequent to permit campground location.

[1] The symbols are used to indicate the nature of the limitation.

[2] See also definitions for coarse fragments, rockiness, stoniness, textural and soil drainage classes in the Manual for Describing Soils in the Field (Canada Soil Survey Committee, 1978).

[3] Surface soil texture influences soil ratings as it affects foot trafficability, dust, and soil permeability.

[4] Moderately well and well drained SC, SiC and C soils may be rated fair.

[5] Coarse fragments for the purpose of this table include gravels and cobbles. Some gravelly soils may be rated as having slight limitations if the content of gravel exceeds 20% by only a small margin, providing (a) the gravel is embedded in the soil matrix, or (b) the fragments are less than 2 cm in size.

[6] Very shallow soils are rated as having a limitation for rockiness and/or stoniness.

Table 28. Guide for assessing soil suitability for picnic areas.

This guide applies to soils considered for intensive use as park-type picnic areas. It is assumed that most vehicular traffic will be confined to the access roads. Soil suitability for growing and maintaining vegetation is not a part of this guide, except as influenced by moisture, but is an important item to consider in the final evaluation of site.

Symbol[1]	Items Affecting Use	Degree of Soil Suitability			
		Good - 0	Fair - 5	Poor - 9	Very Poor - 9
w	Wetness[2]	Very rapidly, rapidly, well and moderately well drained soils not subject to seepage or ponding. Water table below 50 cm during season of use.	Moderately well drained soils subject to occasional seepage or ponding and imperfectly drained soils not subject to ponding or seepage. Water table above 50 cm for short periods during season of use.	Imperfectly drained soils subject to seepage or ponding. Poorly drained soils. Water table above 50 cm and often near surface for a month or more during season of use.	Very poorly drained and permanently wet soils.
f	Flooding	None during season of use.	May flood 1 or 2 times per year for short periods during season of use.	Floods more than 2 times during season of use.	Prolonged flooding during season of use.
s	Slope	0-9%	9-15%	15-30%	>30%
s	Surface Soil Texture[3,4]	SL, FSL, VFSL, L	SiL, CL, SCL, SiCL, LS, and sand other than loose sand.	SC, SiC, C[5]; HS	Peaty soils; loose sand subject to blowing.
c	Coarse Fragments on Surface[6]	0-15%	15-35%	>35%	
p	Stoniness[7]	Stones >3 m apart (Class 0 to 2)	Stones 1-3 m apart (Class 3)	Stones 0.1-1 m apart (Class 4)	Stones <0.1 m apart (Class 5)
r	Rockiness[7,8,9]	Rock exposures roughly 30-100 or more m apart and cover <10% of the surface.	Rock exposures roughly 10-30 m apart and cover 10-25% of the surface.	Rock exposures <10 m apart and cover >25% of the surface.	Rock exposures too frequent to permit location of picnic areas.
a	Useful Moisture[10]	Water storage capacity[11] >15 cm and/or adequate rainfall and/or low evapotranspiration.	Water storage capacity[11] 7.5-15 cm and/or moderate rainfall and/or moderate evapotranspiration.	Water storage capacity[11] <7.5 cm and/or low rainfall and/or high evapotranspiration.	

[1] The symbols are used to indicate the nature of the limitation.

[2] See also definitions for coarse fragments, rockiness, stoniness, textural and soil drainage classes in the Manual for Describing Soils in the Field (Canada Soil Survey Committee, 1978). Coarse fragments for the purposes of this table, include gravels and cobbles. Some gravelly soils may be rated as having a slight limitation if the content of gravel exceeds 35% by only a small margin providing (a) the gravel is embedded in the soil matrix, or (b) the fragments are less than 2 cm in size.

[3] Surface soil texture influences soil ratings as it affects foot trafficability, dust and soil permeability.

[4] Moderately well and well drained SC, SiC and C soils may be rated fair.

[5] Very shallow soils are rated as having severe or very severe limitations for stoniness or rockiness.

[6] The nature and topography of the bedrock exposures may significantly alter these ratings. In such, on-site investigations will be necessary in any units containing bedrock when these are considered as possible sites.

[7] This item attempts to evaluate the adequacy of moisture for vegetative growth. It incorporates the concept of supply through rainfall, loss through evapotranspiration, and storage within the rooting zone. In soils where the water table is within rooting depth for a significant portion of the year, water storage capacity may not significantly influence vegetative growth.

[8] Consult glossary for definitions of terms used.

Table 29. Guide for assessing soil suitability for paths and trails.

It is assumed that the trails will be built at least 45 cm wide and that obstructions such as cobbles and stones will be removed during construction. It is also assumed that a dry, stable tread is desirable and that muddy, dusty, worn or eroded trail treads are undesirable. Hiking and riding trails are not treated separately, but as the design requirements for riding trails are more stringent, a given limitation will be more difficult to overcome. Poor or very poor suitability does not indicate that a trail cannot or should not be built. It does, however, suggest higher design requirements and maintenance to overcome the limitations.

Symbol[1]	Items[2] Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
e	Texture[3],[4]	SL, FSL, VFSL, L, SiL	SiCL, CL, SiCL, SCL	SC, SiC, C[5]; Sand, LS	Peaty soils; loose sand subject to blowing
c	Coarse Fragment Content[3],[4]	0-20%	20-30%	>30%	
p	Stoniness[4]	Stones >3 m apart (Class 0 to 2)	Stones 1-3 m apart (Class 3)	Stones 0.1-1 m apart (Class 4)	Stones <0.1 m apart (Class 5)
w	Wetness[4]	Very rapidly, rapidly well, and moderately well drained soils. Water table below 50 cm during season of use.	Moderately well drained soils subject to occasional seepage and ponding and imperfectly drained soils. Water table may be above 50 cm for short periods during season of use.	Poorly and very poorly drained soils. Water table above 30 cm and often near surface for a month or more during season of use.	Permanently wet soils.
r	Rockiness[4],[6]	Rock exposures >30 m apart and cover <10% of the surface.	Rock exposures 10-30 m apart and cover 10-25% of the surface.	Rock exposures <10 m apart and cover >25% of the surface.	Rock exposures too frequent to permit location of paths and trails.
t	Slope[7]	0-15%	15-30%	30-60%	>60%
i	Flooding	Not subject to flooding during season of use.	Floods 1 or 2 times during season of use.	Floods more than 2 times during season of use.	Subject to prolonged flooding during season of use.

[1] The symbols are used to indicate the nature of the limitation.

[2] The items affecting use listed in this table are those which have been shown to cause significant differences in trail response. Elevation, aspect, position on slope, and snow avalanching may have slight effects or influence trail management and should be considered in the final site evaluation. Items such as vegetation, fauna, and scenic value are not considered in the guidelines (Epp, 1977).

[3] Texture refers to the soil texture which will form the tread texture. This is the surface texture on level areas but may be a subsurface texture on slopes. Textural classes are based on the less than 2 mm soil fraction. Texture influences soil ratings as it influences foot trafficability, dust, design or maintenance of trails, and erosion hazards.

[4] See also definitions for coarse fragments, rockiness, stoniness, textural and soil drainage classes in the Manual for Describing Soils in the Field (Canada Soil Survey Committee, 1978).

[5] Moderately well and well drained SC, SiC and C soils may be rated fair.

[6] Coarse fragments for the purpose of this table, include gravels and cobbles. Gravels tend to cause unstable footing when present in high amounts, and are also associated with increased erosion. Cobbles (and stones) must be removed from the trail tread, increasing construction and maintenance difficulties. Some gravelly soils may be rated as having a slight limitation if the content of gravel exceeds 20% by only a small margin providing (a) the gravel is embedded in the soil matrix or (b) the fragments are less than 2 cm in size.

[7] The type of rock outcrop (flat lying vs cliffs), and the orientation of the structure (linear cliffs vs massive blocks) can greatly alter the degree of the limitation. Each site with a Rockiness limitation based on the percent rock outcrop above should be evaluated on its own merits and the degree of limitation should then be modified appropriately if necessary.

[8] Slope in this context refers to the slope of the ground surface, not the slope of the tread.

Appendix F

GUIDES FOR ASSESSING SOIL SUITABILITY FOR AGRICULTURAL LAND USE

Definitions of the Agricultural Capability Classes

Class 1

Soils in this class have no important limitations for crop use. The soils have level or gently sloping topography; they are deep, well to imperfectly drained and have moderate water holding capacity. The soils are naturally well supplied with plant nutrients, easily maintained in good tilth and fertility; soils are moderately high to high in productivity for a wide range of cereal and special crops.

Class 2

Soils in this class have moderate limitations that reduce the choice of crops or require moderate conservation practices. The soils have good water holding capacity and are either naturally well supplied with plant nutrients or are highly responsive to inputs of fertilizer. They are moderate to high in productivity for a fairly wide range of crops. The limitations are not severe and good soil management and cropping practices can be applied without serious difficulty.

Class 3

Soils in this class have moderate limitations that restrict the range of crops or require moderate conservation practices. The limitations in Class 3 are more severe than those in Class 2 and conservation practices are more difficult to apply and maintain. The limitations affect the timing and ease of tillage, planting and harvesting, the choice of crops and maintenance of conservation practices. The limitations include one or more of the following: moderate climatic limitation, erosion, structure or permeability, low fertility, topography, overflow, wetness, low water holding capacity or slowness in release of water to plants, stoniness and depth of soil to consolidated bedrock. Under good management, these soils are fair to moderately high in productivity for a fairly wide range of field crops.

Class 4

Soils in this class have severe limitations that restrict the choice of crops or require special conservation practices or both. These soils have such limitations that they are only suited for a few crops, or the yield for a range of crops may be low, or the risk of crop failure is high. The limita-

tions may seriously affect such farm practices as the timing and ease of tillage, planting and harvesting, and the application and maintenance of conservation practices. These soils are low to medium in productivity for a narrow range of crops but may have higher productivity for a specially adapted crop. The limitations include the adverse effects of one or more of the following: climate, accumulative undesirable soil characteristics, low fertility, deficiencies in the storage capacity or release of soil moisture to plants, structure or permeability, salinity, erosion, topography, overflow, wetness, stoniness, and depth of soil to consolidated bedrock.

Class 5

Soils in this class have very severe limitations that restrict their capability to producing perennial forage crops, and improvement practices are feasible. These soils have such serious soil, climatic or other limitations that they are not capable of use for sustained production of annual field crops. However, they may be improved by the use of farm machinery for the production of native or tame species of perennial forage plants. Feasible improvement practices include clearing of bush, cultivation, seeding, fertilizing and water control.

Some soils in Class 5 can be used for cultivated field crops provided unusually intensive management is used. Some of these soils are also adapted to special crops requiring soil conditions unlike those needed by the common crops.

Class 6

Soils in this class are capable only of producing perennial forage crops and improvement practices are not feasible. Class 6 soils have some natural sustained grazing capacity for farm animals, but have such serious soil, climatic or other limitations as to make impractical the application of improvement practices that can be carried out on Class 5 soils. Soils may be placed in this class because their physical nature prevents the use of farm machinery, or because the soils are not responsive to improvement practices, or because stock watering facilities are inadequate.

Class 7

Soils in this class have no capability for arable culture or permanent pasture because of extremely severe limitations. Bodies of water too small to delineate on the map are included in this class. These soils may or may not have a high capability for forestry, wildlife and recreation.

Table 40 Land Classification Standards for Irrigation Suitability.

Land Characteristics	Subclass	Class 1 - Very Good	Class 2 - Good	Class 3 - Fair	Class 4 - Poor
SOILS	S				
Texture very coarse textured very fine textured		v Fine sandy loams to h clay loams	Loamy fine sand to light clay	Sand to permeable clay	Gravel to clay
Water holding capacity low available moisture capacity		q 40 to 60 sat. % >15cm storage in 1.2m <10cm/hr. hydraulic cond.	35 to 65 sat. % >12.5cm storage in 1.2m <12.5cm/hr. hydraulic cond.	25 to 75 sat. % >7.5cm storage in 1.2m <17.5cm/hr. hydraulic cond.	<25 or >75 sat. % <7.5cm storage in 1.2m >17.5cm/hr. hydraulic cond.
Geological Deposit shallow deposit over sand or gravel		k .9m or more of fine sandy loam or heavier	.6m or more of fine sandy loam or heavier, or .75m plus of loamy fine sand or sandy loam	.3m or more of sandy loam or heavier, or .6m plus of loamy sand	<.3m of sandy loam or heavier, or .6m of loamy sand or sand
shallow deposit over impervious substrate		b >3m of permeable material	>2m of permeable material	>1m of permeable material	<1m of permeable material
Salinity and Alkalinity[1,2]		a <4 ms/cm in 0-.6m <8 ms/cm below .6m <6 S.A.R.	<4 ms/cm in 0-.6m <12 ms/cm below .6m <8 S.A.R.	<8 ms/cm in 0-.6m <15 ms/cm below .6m <12 S.A.R.	>8 ms/cm in 0-.6m >15 ms/cm below .6m >12 S.A.R.
EXTERNAL FEATURES Stones - rock clearing		r None to light clearing	Light to medium clearing	Light to heavy clearing	Excessively stony
Topography Slope excess gradient	T	g <1% and 0.1% in general gradient (0-3% slope)	<3% in general gradient (3-5% slope)	<5% in general gradient (5-10% slope)	>5% in general gradient (>10% slope)[oo]
DRAINAGE restricted outlet	D	No problem anticipated	Moderate drainage problem anticipated but may be improved at relatively low cost	Moderate to severe drainage problem anticipated but may be improved by expensive but feasible measures	Drainage improvement not considered feasible
water table		below 2.4m most of year	could be above 1.2m for a short period, then recedes to 2.4m or lower	within 1.2m most of year	within 1m most of year

o Criteria for gravity (flood) irrigation requirements.

oo Estimated adjustments to slope criteria for overhead or sprinkler type irrigation methods.

1 If sufficient gypsum is present in the soil, the S.A.R. may be lowered by leaching the soil (a very slow process), and the hydraulic conductivity may then improve.

2 The degree of salinity may vary widely within short distances, and there may be no clear indication of the area occupied by each salinity class. Unless a very detailed mapping and sampling program is carried out, it is impossible to estimate the acreage occupied by each salinity class.

Appendix G

SOIL CORRELATION OF SOUTH RIDING MOUNTAIN PLANNING DISTRICT WITH ROSSBURN-VIRDEN AND WESTLAKE MAP AREAS

The South Riding Mountain Study Area comprises thirteen detailed map areas that replace portions of the 1956 reconnaissance soil survey of the Rossburn and Virden map sheet and of the 1958 reconnaissance soil survey of the Westlake map sheet. This resurvey benefits from advantages derived from more intensive examination of soils in the field, use of a larger mapping scale to permit delineation of numerous important local soils, use of modern aerial photographs and use of improved methods of studying soils in the laboratory.

The detailed soil maps of the South Riding Mountain study area differ substantially from the 1956 Rossburn-Virden, and the 1958 Westlake reconnaissance maps. The major difference between them is in the scale and degree of detail shown.

In the reconnaissance maps of the Rossburn-Virden sheet and Westlake sheet, each unit shown is a compound unit consisting of a complex of soil types known as a "soil association", having a dominant soil type interspersed with related but unlike local soil types in lesser proportion. While soil associations are shown as units on the reconnaissance map, local associated soils and textural classes are occasionally mapped and designated as separate units where areas involved are substantial or where such units are of sufficient local importance. These individual associated soils developed on similar kinds of soil parent material are referred to as "soil associates". They are recognized by differences in their soil profile characteristics as a result of differences in topographical position, which in turn affects drainage and soil climate, often over short intervals in the same field. For example, on hummocky glacial till in the Gray-Black soil zone in the Rossburn Sheet, the prevailing well drained soil will be the Orthic Dark Gray type; the soil on intermediate or lower slopes may be a Gleyed Dark Gray, while in the depressions, either Rego Humic or leached Humic Luvic Gleysols may be found. Each of these soils developed on the same geologic deposit will show different profile characteristics when examined in cross section.

In the present detailed maps of the South Riding Mountain study area, each unit shown is either a simple unit consisting of a single soil type referred to as a "soil series" or a specifically defined compound unit containing one dominant soil series and usually one other related but unlike soil series associated with it. Soil series in terms of current Canadian Soil Classification criteria (1987)[18] are approximately equivalent to soil associates as defined in the 1956 study. In general, the range in allowable variation in profile char-

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[18] Agriculture Canada Expert Committee on Soil Survey. 1987. The Canadian system of soil classification. 2nd ed. Agric. Can. Publ. 1646, 164 pp.

acteristics and properties of soil series is significantly less than the range permitted in so-called soil associates. In this study, these more specifically defined soil series are also grouped in more narrowly defined soil associations to accommodate field classification. Correlation of these redefined soil associations and soil series with the soil associations and soil associates of the 1956 and 1958 studies is provided in Table 41.

Table 41. Correlation of the Soil Series of the South Riding Mountain Planning District Study Area with the Soil Associates of the Rossburn and Virden Map Sheet, 1956 and the Westlake Map Sheet, 1958.

Soil Symbol	Soil Name	Subgroup	Soil Associations 1956, 1958 Surveys	Soil Associate Equivalents; 1956, 1958 Surveys
BAX	Banks	Orthic Dark Gray	Onanole/Till Substrate	Well drained, Degrading Black to Dark Gray Wooded
BHY	Bethany	Gleyed Rego Black	Marringhurst	Imperfectly drained, Black-Meadow
BKO	Breckon	Rego Humic Gleysol	Meadowbrook	Poorly drained, Meadow
BWG	Bluewing	Dark Gray Luvisol	Rackham, sandy loam	Well drained, Gray Wooded
BYH	Baynham	Typic Mesisol	Peat, Bog	Very poorly drained, organic deposits over 30 inches thick
CAY	Cayer	Terric Mesisol	Half Bog	Very poorly draned, organic deposits 12-30 inches thick
DKS	Dickson	Gleyed Dark Gray	Selina, Till Substrate	Imperfectly drained, Degrading Black to Dark Gray Wooded
DVD	Davidson	Orthic Dark Gray	Onanole, sandy loams	Well drained, Degrading Black to Dark Gray Wooded
ECK	Erickson	Orthic Dark Gray	Erickson	Well drained, Degrading Black to Dark Gray Wooded
HEC	Heron Creek	Rego Humic Gleysol	Seech	Poorly drained, Meadow, Peaty Meadow
HRD	Horod	Orthic Black	Marringhurst	Well drained, Black
KHI	Katherine	Gleyed Dark Gray	Leary	Imperfectly drained, Degrading Black-Meadow
KIC	Kircro	Terric Mesisol	Half Bog	Very poorly drained, organic deposits 12-30 inches thick
LSW	Lenswood	Gleyed Rego Black	Onanole, sandy loams	Imperfectly drained Calcareous Black-Meadow
MHC	Marsh	Rego Gleysol	Marsh	Very poorly drained, undifferentiated deposits
MWK	Meadowbrook	Orthic Dark Gray	Meadowbrook	Well drained, Degrading Black to Dark Gray Wooded
OKO	Okno	Terric Mesisol	Half Bog	Very poorly drained, organic deposits 12-30 inches thick
OOL	Onanole	Orthic Dark Gray	Onanole, loams	Well drained, Degrading Black to Dark Gray Wooded
OZA	Ozerna	Orthic Dark Gray	Leary, Till Substrate	Well drained, Degrading Black to Dark Gray Wooded
PPL	Poppleton	Gleyed Dark Gray	Selina	Imperfectly drained, Degrading Black to Dark Gray Wooded
PTU	Petlura	Gleyed Dark Gray	Erickson	Imperfectly drained, Degrading Black to Dark Gray Wooded
PVK	Proven Lake	Rego Humic Gleysol	Onanole, loams	Poorly drained, Meadow and Peaty Meadow
RBN	Roblin	Humic Luvic Gleysol	Erickson	Poorly drained, Degrading Meadow
RKH	Rackham	Orthic Gray Luvisol	Rackham, loams	Well drained, Gray Wooded
RTV	Rat River	Terric Mesisol	Half Bog	Very poorly drained, organic deposits 12-30 inches thick

Soil Symbol	Soil Name	Subgroup	Soil Associations 1956, 1958 Surveys	Soil Associate Equivalents; 1956, 1958 Surveys
SDB	Sand Beach	Orthic Regosol	Unclassified	Dominantly well drained
SHH	Seech	Calcareous Black	Marringhurst	Well drained, Calcareous Black
SHH(c)	Seech	Orthic Black	Marringhurst	Well drained Black
SNT	Sinnott	Rego Humic Gleysol	Erickson	Poorly drained, Meadow, Calcareous Meadow
STD	Stead	Typic Mesisol	Bog, Peat	Very poorly drained, organic deposits over 30 inches thick
SWF	Swanford	Gleyed Rego Black	Carroll, loams	Imperfectly drained
SWN	Swan	Gleyed Dark Gray	Onanole	Imperfectly drained, Degrading Black to Dark Gray Wooded
TEK	Tee Lake	Gleyed Gray Luvisol	Waitville	Imperfectly drained, Gray Wooded
VLY	Valley	Gleyed Rego Black	Carrol, clay loams	Imperfectly drained, Black-Meadow
VST	Vista	Rego Humic Gleysol	Onanole, sandy loams	Poorly drained, Meadow, Peaty Meadow
WPU	Wapus	Orthic Gray Luvisol	Wapus	Well drained, Gray Wooded
WTV	Waitville	Orthic Gray Luvisol	Waitville	Well drained, Gray Wooded
ZAP	Zaparoza	Orthic Gray Luvisol	Zaparoza	Well drained, Gray Wooded

Appendix H

SOILS OF THE SOUTH RIDING MOUNTAIN PLANNING DISTRICT AREA MAP LEGEND

Soil Symbol	Soil Name	Drainage	Dominant Surface Texture and Parent Material	Soil Classification Subgroup	Phase
BAX	Banka	Well	Loam; moderate to strongly calcareous, fine loamy lacustrine deposits overlying moderate to strongly calcareous, fine loamy morainal till.	Orthic Dark Gray	
BHY	Bethany	Imperfect	Loamy fine sand; moderate to strongly calcareous, fine sandy to sandy skeletal beach and outwash deposits.	Gleyed Rego Black	Carbonated
BKO	Brockon	Poor	Clay; weakly to moderately calcareous, clay textured, stone-free glaciolacustrine deposits.	Rego Humic Gleysol	
BWG	Bluewing	Well	Loamy fine sand; moderately to strongly calcareous, coarse to moderately coarse textured sandy lacustrine sediments.	Dark Gray Luvisol	
BYH	Baynham	Very Poor	Peat; deep, moderately well decomposed organic deposits derived from forest type vegetation overlying undifferentiated materials.	Typic Mesisol	
CAY	Cayer	Very Poor	Peat; thin, moderately decomposed organic deposits derived from fen type vegetation overlying medium to fine textured lacustrine deposits.	Terric Mesisol	Clay Substrate
DKS	Dickson	Imperfect	Fine sandy loam; moderately calcareous, coarse to moderately coarse textured sandy lacustrine deposits overlying moderately to strongly calcareous, fine loamy morainal till.	Gleyed Dark Gray	
DVD	Davidson	Well	Loamy sand; weak to moderately calcareous, coarse loamy to sandy textured lacustrine deposits.	Orthic Dark Gray	
ECK	Erickson	Well	Loam; moderate to strongly calcareous, medium to moderately fine textured morainal tills.	Orthic Dark Gray	
HEC	Heron Creek	Poor	Loamy fine sand; moderately to strongly calcareous, coarse textured gravelly deltaic, beach or outwash deposits.	Rego Humic Gleysol	
HRD	Horod	Well	Sandy loam; moderately calcareous, medium sand lacustrine deposits.	Orthic Black	
KHI	Katherine	Imperfect	Loamy fine sand; moderately to strongly calcareous, coarse textured gravelly deltaic, beach or outwash deposits.	Gleyed Dark Gray	
KIC	Kircro	Very Poor	Peat; thin, moderately decomposed organic deposits derived from fen type vegetation overlying coarse to moderately coarse textured lacustrine deposits.	Terric Mesisol	Sand Substrate
LSW	Lenswood	Imperfect	Fine sandy loam; moderately calcareous, coarse textured sandy deposits.	Gleyed Rego Black	Carbonated
MHC	Marsh	Very Poor	Undifferentiated (mainly fine loamy) mineral soil deposits.	Rego Humic Gleysol	Carbonated
MWK	Meadowbrook	Well	Clay; moderately to strongly calcareous, medium to moderately fine textured morainal till.	Orthic Dark Gray	
OKO	Okno	Very Poor	Peat; thin, moderately decomposed organic deposits derived from forest type vegetation overlying moderately calcareous, medium to fine textured lacustrine deposits.	Terric Mesisol	Clay Substrate
OOL	Onanole	Well	Loam; moderately to strongly calcareous, medium to moderately fine textured lacustrine deposits.	Orthic Dark Gray	
OZA	Ozerna	Moderately Well	Sandy loam; moderate to strongly calcareous, coarse loamy lacustrine deposits overlying moderately to strongly calcareous, fine loamy morainal till.	Orthic Dark Gray	
PPL	Poppleton	Imperfect	Fine sandy loam; moderately calcareous, coarse to moderately coarse textured sandy lacustrine deposits.		
PTU	Petlura	Imperfect	Loam; moderate to strongly calcareous, fine loamy, stony, morainal till	Gleyed Dark Gray	

Soil Symbol	Soil Name	Drainage	Dominant Surface Texture and Parent Material	Soil Classification Subgroup	Phase
PVK	Proven Lake	Poor	Clay loam; moderately calcareous, moderately fine textured stratified lacustrine deposits.	Rego Humic Gleysol	
PVK(p)	Proven Lake	Very Poor	Peat; thin, mesic peat, overlying moderately calcareous, moderately fine textured stratified lacustrine deposits.	Rego Humic Gleysol	Peaty
RBN	Roblin	Poor	Loam; weakly to moderately calcareous, fine loamy to clayey deposits in depressional areas of fine loamy morainal till.	Humic Luvic Gleysol	
RKH	Rackham	Well	Fine sandy loam; moderately to strongly calcareous, medium to moderately fine textured lacustrine deposits.	Orthic Gray Luvisol	
RTV	Rat River	Very Poor	Peat; moderately decomposed organic deposits derived from forest type vegetation overlying weakly to moderately calcareous sandy glacio-fluvial deposits.	Terric Mesisol	Sand Substrate
SDB	Sand Beach	Rapid to Poor	Fine to medium sand; weakly to moderately calcareous stratified sandy to gravelly water sorted shore line deposits of variable thickness.	Gleyed Regosol	
SHH	Seech	Well	Loamy fine sand; moderately to strongly calcareous, coarse sandy to coarse gravelly deltaic, beach or outwash deposits.	Calcareous Black	
SHH(c)	Seech classification variant	Well	See SHH	Orthic Dark Gray	
SNT	Sinnott	Poor	Clay loam; moderately to strongly calcareous, medium to moderately fine textured morainal till.	Rego Humic Gleysol	
SNT(p)	Sinnott	Very Poor	Peat; thin, mesic organic deposits overlying moderately to strongly calcareous, medium to moderately fine textured morainal till.	Rego Humic Gleysol	Peaty
STD	Stead	Very Poor	Peat; deep, moderately to well decomposed organic deposits derived from fen type vegetation overlying undifferentiated materials.	Typic Mesisol	
SWF	Swanford	Imperfect	Fine sandy loam; moderately to strongly calcareous, medium to moderately fine textured lacustrine deposits.	Gleyed Rego Black	Carbonated
SWN	Swan	Imperfect	Loam; moderately to strongly calcareous, medium to moderately fine textured lacustrine deposits.	Gleyed Dark Gray	
TEK	Tee Lake	Imperfect	Clay loam; moderately to strongly calcareous fine loamy, stony, morainal till.	Gleyed Gray Luvisol	
VLY	Valley	Imperfect	Loam; moderately to strongly calcareous, medium to moderately fine textured lacustrine deposits.	Gleyed Rego Black	Carbonated
VST	Vista	Poor	Fine sandy loam; moderately calcareous, coarse textured sandy deposits.	Rego Humic Gleysol	
VST(p)	Vista	Very Poor	Peat; thin, mesic peat, overlying moderately calcareous, coarse textured sandy deposits.	Rego Humic Gleysol	Peaty
WLM	Wellman	Imperfect	Clay; moderately to strongly calcareous, medium to moderately fine textured morainal till.	Gleyed Dark Gray	
WPU	Wapue	Well	Fine sandy loam to clay loam; non to weakly calcareous, thin coarse textured morainal till overlying weathered shale.	Orthic Gray Luvisol	
WTV	Waitville	Well	Loam; moderately to strongly calcareous, stony, medium to moderately fine textured morainal till.	Orthic Gray Luvisol	
ZAP	Zaparosa	Well	Loamy fine sand; extremely calcareous, coarse sandy to gravelly deltaic, beach or outwash deposits.	Orthic Gray Luvisol	